THE FIRST "A" IN NASA

HEARING

BEFORE THE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

OF THE

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-SEVENTH CONGRESS

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[*] On assignment to Budget Committee for 97th Congress.

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THE FIRST "A" IN NASA

TUESDAY, DECEMBER 8, 1981

House of Representatives,
Committee on Science and Technology,
Subcommittee on Transportation,
Aviation and Materials,
Washington, D.C.

The subcommittee met, at 9:50 a.m., in room 2318, Rayburn House Office Building, Hon. Dan Glickman (chairman of the subcommittee) presiding.

Present: Representatives Glickman, Fuqua, Dunn, Flippo, Harkin, and Shamansky.

Mr. **Glickman**. The hearing will come to order.

The first order of business is to ask unanimous consent to permit video and audio reporting in the hearing room today. Without objection, it will be permitted.

The hearing today is related to subject matter which is of deep concern to this committee; and that is the role of NASA generally, but specifically how it relates to aeronautics.

To most Americans, the letters "NASA" mean only one thing—the space agency.

We have all shared in the Nation's exhilaration as brave young men tested nature's ultimate preserve. We have all marveled at the scientific and technical mastery that stood behind them. And we have all shared an immense national pride in their remarkable achievements. So, it is easy to understand why NASA means space to most people; and well it should.

But there is another side to NASA. It is a side that frequently gets overlooked. But it is a side that has great importance to our national security and economic well-being, and that is the first "A", or aeronautics side.

Aeronautics is small, accounting for only 10 percent of NASA's total budget. It is a low profile activity. Few members of the general public are even aware that it exists. But its impact reaches to the very core of our national security and economic well-being.

Last year alone, the United States bought $23 billion more from foreign countries than we sold to them. The year before, it was $27 billion. Yet, alarming as these statistics are, they would have been much worse, were it not for the export of U.S.-made aircraft. In fact, the number for 1980 would have been almost $12 billion worse.

Now, that may be just another number to most of us, but to roughly 1 million Americans who build these airplanes, it is a livelihood for them and their families.

I am among those who believe that this kind of success didn't just happen. We didn't just become preeminent in the world of aviation by luck or accident; there were a lot of causal factors. But surely, one of them was the longstanding Government practice of supporting long-range aeronautical research and development. Ever since 1915, when the National Advisory Committee on Aeronautics was established, the Federal Government and private industry have worked closely to keep U.S. military and civil aircraft in front of their competition.

This arrangement has worked exceptionally well, as I have indicated. In fact, the total amount expended by NACA and NASA over their combined 65 years of existence on aeronautical research, facilities, and personnel is less than half the value of aeronautical exports in 1980 alone.

But now, there are those in the administration who want to change this proven and cost-effective way of doing business. They say private industry should bear the entire cost of R. & D. leading to products that it hopes to sell. They say NASA's work is a subsidy to industry and should be drastically curtailed. Suggestions have ranged from turning aeronautics over to the military, to ending all propulsion work, and closing the Lewis Research Center in Cleveland, and to zeroing the entire program.

I might mention that Aerospace Daily reported on Friday that OMB would cut NASA's aeronautical research and technology budget to more than half from the requested $371 million, to $139 million; thus eliminating all systems technology programs.

As the subcommittee responsible for authorizing the NASA aeronautics program, I feel we must fully understand the consequences of such radical departures from historical practice. For this reason we have asked some of the most knowledgeable people in aviation to come here today and to speak to the underlying justification for NASA's unique partnership with industry and whether its continuation still serves the national interest.

Before I turn to our full committee chairman, the gentleman who is probably as responsible for the success of NASA as anybody else, I would like for the record to include three letters.

One is a letter from Caspar Weinberger to David Stockman; one is a letter from J. R. Scully, Assistant Secretary of the Army, to James Beggs, Administrator of NASA; and one is a letter from Richard de Lauer, Under Secretary of Defense for Research and Engineering, to Jim Beggs. All, including Mr. Weinberger's, seriously question the proposed OMB cuts in NASA and what that would do to military technology.

[The letters follow:]

THE SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

Mr. David Stockman
Director,
Office of Management and Budget
Washington, D.C. 20510

Dear Dave:

We have been advised that OMB is proposing major reductions in the NASA FY 1982 and FY 1983 aeronautics technology programs. We understand that this action will result in the closing of the Lewis Research Center and in significant reductions in technical manpower.

NASA aeronautics research facilities and technical capabilities have been and will continue to be critical to the development of military aircraft. The successful development of the B-1B, Advanced Technology Bomber, Next Generation Air Force Fighter and the Marine Corps transport assault aircraft are critically dependent on the availability of NASA facilities and technical specialists.

I am deeply concerned that the proposed reductions will adversely impact the above programs, and are not consistent with DoD needs. Therefore, I request that, before any budget reductions and subsequent management actions are taken which impact the NASA aeronautics program, this department be given the opportunity to review these actions to insure that they will not adversely affect important defense needs.

Sincerely,

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DEPARTMENT OF THE ARMY
OFFICE OF THE ASSISTANT SECRETARY
WASHINGTON, D.C. 20310

1 DEC 1981

Dr. James Beggs
Administrator, National Aeronautics & Space Administration
600 Independence Avenue, SW
Washington, DC 20546

Dear Dr. Beggs:

I have recently been advised that substantial reductions in the NASA FY.1982 and FY 1983 aeronautics technology program are currently being considered by the Office of Management and Budget (OMB). I also understand that this action could result in the closing of the Lewis Research Center in Cleveland, Ohio with the potential of significant reductions in technical personnel not only at Lewis Research Center, but at the Ames and Langley Centers as well.

As you are aware, the Research and Technology Laboratories of the Army's Aviation R&D Command (AVRADCOM) have been operating under highly productive Joint Agreements for cooperative research with these NASA Aeronautical Centers since 1965. The expertise resident at those centers as well as the unique aeronautical facilities are absolutely essential to the Army in furthering its aviation R&D programs. These Agreements have enabled the Army to establish an outstanding in-house R&D Laboratory capability with a minimum investment in acquisition and operation of facilities and with access to a reservoir of experienced personnel. The Army Aviation's military posture, as well as the US helicopter technology base have been significantly enhanced since the inception of the Joint Agreements in 1965.

The Army's interest and concern in NASA's systems technology programs stem from the fact that these programs support the operation of key flight and ground-based facilities crucial to continuing the Army's aviation R&D programs. The Army's reliance on these programs means that substantial reductions in the NASA funding for these activities would necessitate the Army incurring major increases in our existing and proposed budget and personnel requirements to offset these NASA reductions. In fact, some of these capabilities and facilities could not be replaced by the US Army at any cost.

Over the years the Army has found a unique and truly effective means by which to meet its need for an in-house aviation R&D Laboratory. Through these Joint Agreements we have shared our resources to pursue our common interest in low speed aeronautical research at considerable cost savings. I only hope that OMB

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would strongly consider the potentially significant impact in both capital investment and personal turmoil before making final resolution on the NASA's aeronautical budget. My office is ready to provide you with any supportive information you may require in this regard.

Sincerely,

J R Sculley

J.R. Sculley
Assistant Secretary of the Army
(Research, Development and Acquisition)

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THE UNDER SECRETARY OF DEFENSE
WASHINGTON D C 20301

RESEARCH AND
ENGINEERING

30 NOV 1981

Dr. James Beggs
Administrator,
National Aeronautics and Space Administration
Washington, D. C. 20546

Dear Jim:

We have been advised that OMB is proposing major reductions in the NASA FY 1983 aeronautics technology program, as well as additional reductions in FY 1982 and in the out-years. We understand that the proposed program will result in closing the Lewis Research Center, and in substantial reductions in aeronautics activities at the Ames and Langley Research Centers. In addition, there is a proposed reduction of some 1300 in-house personnel in the aeronautics program.

These proposed actions will significantly affect the needs of the Department of Defense. The continued superiority of US aeronautical technology, and the historic dependence of the Military Services on NASA facilities and technical specialists have been, and will continue to be crucial to the development of military aircraft. Successful development of the B-1B, Advanced Technology Bomber, Next Generation Air Force Fighter and the Marine Corps transport assault aircraft are critically dependent on a vital and productive NASA aeronautics program.

Specifically, the closing of the Lewis Research Center would directly impact Army programs oriented toward develoment of advanced turboshaft engines for helicopter applications. The Army has fostered collocation of its Aeronautical Research and Technology Laboratories at Ames, Langley and Lewis Research Centers, rather than create separate capability. We have not had time to determine the precise impact on the Army program as a result of closing Lewis; however, it is obvious that the program will have to be substantially altered, with transfer of the activity to another Army laboratory at considerable expense.

My staff has carefully reviewed the proposed NASA aeronautics program funded at \$296M and we fully support that program as being productive and responsive to DoD needs. We recognize it is not possible to precisely determine the division of the NASA aeronautics program between military and civil applications, and that some portion of that \$296M will be devoted to only civil aircraft. However, we should not lose sight of the fact that manufacture of civil aircraft contributes not only to the economy, but also to the maintenance of the industrial base which is so important to DoD under surge conditions.

In closing I would like to observe that, while we have extensive coordination during the development of our respective aeronautics programs, DoD has not been given the opportunity by OMB to review or comment on the impact of the \$100M reduction in the NASA FY 1982 budget or the proposed FY 1983 program funded at \$139M. It is not clear that our critical needs can be met under the proposed OMB action. Therefore, I would like to request that this department be provided with an opportunity to review any actions pertaining to NASA which will affect important defense needs. We are making a similar request directly to OMB.

Sincerely,

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Mr. Glickman. And now I would like to recognize the full committee chairman, Don Fuqua, for any remarks that he might wish to make.

Mr. Fuqua. Thank you very much, Mr. Chairman.

And let me commend you and the subcommittee for initiating these very important hearings. I think you have outlined the importance of aeronautical research for this country; not only for our defense, but also for our economic well-being and the many thousands of jobs that it creates in the country.

And, as you further pointed out, we have been the leader in the world in aeronautical development since its inception. And I think we are on the verge of losing that competitive edge that we have. And these proposed reductions in the aeronautical portion of the budget are certainly going to drive the nail into that coffin, where we will become a second-rate power as far as aviation and aeronautical research is concerned.

You have a very excellent group of witnesses here. They are very knowledgeable in the field of aeronautical research. So, I want to commend you and the subcommittee. And I know this is going to be very helpful in bringing attention to a very, very serious problem.

Not only is aviation being affected, but a lot of other basic research that we are doing in this country is also being threatened by what I think are very shortsighted management decisions affecting the budget in some very crucial areas. This country cannot afford to lose the leadership role we have today.

Mr. Glickman. Thank you, Don.

Mr. Dunn, do you have any comments?

Mr. Dunn. No.

Mr. Glickman. At this time, Mr. Flippo?

Mr. Flippo. Thank you, Mr. Chairman, just one brief comment.

Mr. Chairman, I would commend you and the members of your committee for pointing out the very important things that you are pointing out.

It is obvious that Malthus would have been right many years ago, when he talked about the subsistence level of man except for technology. And it is also very clear that the growth in industries such as aeronautics, computers, electronics, robotics, and communications is really coming from the Federal R. & D. investment that has been made over the last two decades and more. And to the extent that we reduce the funding for these very important activities, it is to that extent that we are mortgaging our future.

And we can see, too, that all great peoples who turned away from exploring the universe, and turned away from research and development—the Vikings, the Portuguese, the Chinese—all of them took a downturn for the worse. And I want to commend you for pointing out the very important point that some Federal expenditures are a part of the problem and some are a part of the solutions. And those things that contribute to our Nation's wealth and understanding are a part of the solution to that problem.

Thank you, Mr. Chairman.

Mr. Glickman. Thank you for those excellent remarks.

Mr. Harkin.

Mr. **Harkin**. As you know, Dan, many people in this country don't even know that there is a first A in NASA, they think it is a space agency, period. They don't know that its first and primary job for all those years prior to space exploration was, of course, aeronautics. And I think it is interesting to note, as Scott Crossfield has reminded me so many times since I became a member of this subcommittee, that we have not flown higher or faster except in the space program, in this country, since 1961. I think it is time we get on with the business of aeronautical R. & D. and start pushing those frontiers back as we did in the past. So, I compliment you on your hearings here.

Mr. **Glickman**. Thank you, Tom.

I might mention that we are fortunate in the subcommittee to have a man of the caliber of Scott Crossfield, who has been with the subcommittee for some years. And anybody in aeronautics knows that Scott probably has more experience in that area than probably any human being alive today.

I would also like, for the record, to note that Senator Cannon of Nevada had wanted to testify. He isn't able to be here. He has submitted testimony for the record, supportive of the NASA program. And, without objection, his entire statement will appear in the record.

[The complete prepared statement follows:]

STATEMENT OF SENATOR HOWARD W. CANNON
BEFORE THE
SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS
COMMITTEE ON SCIENCE AND TECHNOLOGY
HOUSE OF REPRESENTATIVES
DECEMBER 8, 1981

Mr. Chairman, this hearing is a tribute to your perception of the vital role of aviation technology leadership to our national economy, and of the equally vital role of NASA in performing and supporting the research and technology development which has for decades served as the well spring for the Nation's aviation leadership. How fortunate the people of our country are that our predecessors in the Congress, coupled with far sighted leadership then in the White House, had the wisdom to create the NACA in 1915 and NASA in 1958. We can all well believe that hundreds of thousands of unemployed auto, steel, and textile workers, and their millions of family members are wishing that comparable vision might have prevented the misery, bleakness and bitterness of their lives today.

Now, through some elusive process of voodoo economics which our new Administration, having invented, has now so eagerly embraced and enshrined in a priesthood characterized by double speak, we are being asked to prescribe slow death to major elements of the very agency which can contribute so much to the economic goals of the Administration and of the Nation.

WHILE YOU AND I AND YOUR SUBCOMMITTEE COLLEAGUES UNDERSTAND THE ECONOMIC BENEFITS ACCRUING TO THE NATION FROM ITS AVIATION TECHNOLOGY LEADERSHIP, THEY ARE WORTH RESUMMARIZING. I WILL DO THAT IN THE HOPE THAT THE SAME UNDERSTANDING WILL IN TIME PENETRATE THE SOMETIMES IMPENETRABLE LOGIC OF THE ADMINISTRATION'S BUDGET DIRECTOR. THOSE ECONOMIC BENEFITS ARE MEASURED BY:

- A 1980 NET CONTRIBUTION OF OVER $13 BILLION TO OUR TRADE BALANCE
- 1.3 MILLION FULL-TIME JOBS DISTRIBUTED THROUGHOUT OUR 50 STATES
- AVIATION INDUSTRY SALES OF ABOUT $100 BILLION IN PRODUCTS AND SERVICES WHICH AT NOMINAL EARNING LEVELS WOULD RETURN $2-3 BILLION TO THE FEDERAL TREASURY

MR. CHAIRMAN, I UNDERSTAND THAT THE RATIONALE OF THE OMB AND THE ADMINISTRATION RESTS ON THE EXPECTATION THAT THE AVIATION INDUSTRY, STRONG AS IT NOW IS, WILL ITSELF CARRY ON THE ADVANCED TECHNOLOGY DEVELOPMENT AND DEMONSTRATION ROLE WHICH NASA HAS SO ABLY MANAGED AND SUPPORTED OVER THE DECADES. WE HAVE ONLY TO LOOK ABOUT US AT THE SHAMBLES OUR ECONOMY IS NOW IN, OR TO REREAD A LEARNED TREATISE ON ADMINISTRATION ECONOMICS IN THE ATLANTIC MONTHLY, TO ASSESS THE SOUNDNESS OR VALIDITY OF THIS ADMINISTRATION'S ECONOMIC PREMISES AND EXPECTATIONS.

But, Mr. Chairman, I don't want to base my case solely on the proposition that because every major economic premise of this Administration has so far been proven wrong, the same would be true of its plan to wean the aviation industry from its reliance on NASA's advanced technology and demonstration programs. No, I want to point out and illustrate a few specific, but fundamental, flaws in that plan.

An advanced aeronautic development typically involves complex technology, costly one-of-a-kind laboratory facilities, collaboration by a wide range of highly specialized experts in many disciplines, and high risk of technological and economic failure. For example, the on-going program to develop and establish the technological feasibility of an advanced turboprop or propfan propulsion system requires carefully planned and centrally managed participation of a major propeller design company, an engine company, two airframe companies and the world's finest propulsion laboratory at NASA's Lewis Research Center. Under the successful system which has evolved through half a century of progress since NASA and its predecessor agency, NACA, were established by Congress, NASA, and only NASA, can provide the central planning, coordination, technical integration, scheduling, and management of such a complex program. Absent NASA's unique and proven competence to perform that role, our aviation industry would be stifled

BY A COMBINATION OF ANTITRUST CONSTRAINTS, BY PROPRIETARY CONFLICTS, BY UNACCEPTABLE SINGLE COMPANY RISK TAKING. THE RESULT WOULD BE SIMPLE -- NO RESULT. WHO WOULD BE THE PRINCIPAL LOSERS IN THAT SCENARIO? IN THE MYOPIC VISION OF THE OMB, THE INDUSTRY. LET ME TELL YOU HOW WRONG THEY ARE.

WITHIN THIS DECADE THE AIRLINES OF THE ENTIRE FREE WORLD WILL UNDERGO MASSIVE AIRCRAFT REEQUIPMENT PROGRAMS TO REPLACE THOUSANDS OF AIRCRAFT IN THE MEDIUM RANGE, MEDIUM SIZE CATEGORY, WITH NEW, MORE FUEL EFFICIENT TRANSPORTS. FOREIGN CONSORTIA OF GOVERNMENT AND INDUSTRY ARE WELL UNDER WAY AND POISED TO CAPTURE THAT MULTI-BILLION DOLLAR MARKET. NOT ONLY WILL WE LOSE OUR COMMANDING SHARE OF THAT MARKET AND THE FOREIGN TRADE CONTRIBUTION THAT WOULD ENTAIL, BUT OUR OWN AIRLINES WILL BE PURCHASING THOSE FOREIGN AIRCRAFT. HUNDREDS OF THOUSANDS OF U.S. WORKERS THROUGHOUT OUR COUNTRY WOULD BE THE LOSERS.

MR. CHAIRMAN, ONLY LAST YEAR THE AERONAUTICS AND SPACE ENGINEERING BOARD OF THE NATIONAL RESEARCH COUNCIL'S ASSEMBLY OF ENGINEERING COMPLETED AN EXHAUSTIVE INDEPENDENT STUDY OF THE PROPER ROLE OF NASA IN THE NATION'S AERONAUTICS GOALS AND PROGRAMS. THAT STUDY WAS CONDUCTED THROUGH A WOODS HOLE WORKSHOP UNDER THE ABLE CHAIRMANSHIP OF GUY STEVER, WHO WILL TESTIFY TODAY AT YOUR HEARING. LET NOT YOUR SUBCOMMITTEE OR THE CONGRESS FAIL TO SUPPORT THE KEY FINDINGS AND RECOMMENDATIONS OF THAT WORKSHOP AS TO THE VITAL CONTINUING ROLE OF NASA. LET US NOT FALTER IN OUR COMMITMENT TO ALL THE PEOPLE IN OUR COUNTRY TO SUPPORT THAT ROLE AND HELP PRESERVE OUR WORLDWIDE AVIATION LEADERSHIP WHICH STANDS AS ONE OF OUR NATION'S PROUDEST ACHIEVEMENTS.

Mr. GLICKMAN. The name of our first witness today is a household word. Virtually everybody knows Neil Armstrong.

If this hearing were about reductions in the space program, Neil Armstrong would be everybody's choice to lead off. His experience and his accomplishments would guarantee the Nation's attention. But for the subject of aeronautics, his credentials are just as valid.

He began his career at the Lewis Research Center in Cleveland, as a research pilot. Later, he flew research airplanes, including the X-15, at Edwards Air Force Base. And after his days with the space program, he was Deputy Associate Administrator for Aeronautics at NASA headquarters, and then a professor of aerospace engineering.

You know, Neil, you are just as much an aeronaut as you are an astronaut. It is a pleasure to have you here. We appreciate your testimony and look forward to what you have to say.

STATEMENT OF NEIL ARMSTRONG, CHAIRMAN OF THE BOARD, CARDWELL INTERNATIONAL, LTD.

Mr. ARMSTRONG. Thank you, Mr. Chairman.

Mr. Chairman, Chairman Fuqua, distinguished members of this subcommittee, this subcommittee's reexamination of NASA's relationship with the military, industry, and academia is particularly appropriate and timely. I am delighted to be invited to present a few comments on those associations.

America takes pride in its identity as the birthplace of aviation, and properly so. Early development, however, was erratic and disjointed. We look back on World War I and recognize that American combat flyers had all flown in foreign-built aircraft. Necessity is the mother of invention, however, and airplane improvement emerged rapidly during the war. Those improvements were primarily European. American designs and manufacturing ability lagged far behind.

Many in our Nation recognized this vulnerability after the First World War, and initiated action to prevent its recurrence. NACA, an advisory committee spawned during the First World War, soon accepted research responsibilities and developed facilities for testing new concepts. The Congress encouraged aviation development with the Air Mail Act, in 1925, and the Air Commerce Act, in 1926. And the military increased their expenditures for the acquisition of new aircraft, and developed new concepts of aerial warfare. Within two decades, the investments had paid handsome dividends. American fighting machines in World War II were among the best available in the world.

The war, once again, spurred rapid development. The jet engine, radar, and sweptwing emerged from European research. The American aviation partnership now, however, was well positioned to incorporate these new innovations with their own developments. American postwar military aircraft and commercial transports were substantially the best in the world. Our security and our economy were significantly strengthened.

Since NACA's absorption into NASA, aeronautical programs have been steadily eroded in quantity although not necessarily in quality. Substantial efforts in the 1960's were developed toward improvements in aircraft noise and pollution, mirroring major concerns of the day. Similarly, the 1970's found specific interest in improvements in aircraft efficiency, with reduction of fuel consumption now, understandably, in the national interest.

During the period of NASA's decreasing involvement in aeronautical research, foreign manufacturers and international consortiums have achieved major inroads, particularly in the American civil market. And those are foreign markets that have, historically, been dominated by American aircraft products.

I would not want to imply that the long slide in NASA's aeronautical research is uniquely responsible for the success of our overseas competitors. Political realities and economic considerations, particlarly Government-insured financing, have often been instrumental in the loss of American aircraft sales to foreign producers.

I am reminded of Dickens' opening line in the "Tale of Two Cities": "It was the best of times, it was the worst of times." Each generation seems to feel that that situation characterizes its own existence.

I applaud the administration's efforts and the efforts of this Congress toward maximizing the best of times and minimizing the worst of times by reductions in unnecessary and unproductive spending. Indeed, I accept the necessity for all the citizenry to suffer, to some extent, in the process. In your deliberations you strive to provide safety and security to our society, to strengthen those institutions which best insure the blessings of liberty to our society. Your intent is to nurture those public investments that will provide substantial returns.

Many well-informed observers have persuaded me—and my own experience confirms—that NASA's aeronautical research program ranks well among such public investments. Indeed, this Congress, in its history of careful reviews of those programs, has concluded likewise. For my own part, I must point out that I have been separated from the aeronautics program for some years, and cannot be considered completely qualified to evaluate details of current work and facilities. Fortunately, other witnesses that follow are deeply involved, well informed, and able to provide more carefully reasoned opinions than I.

I appreciate the opportunity to appear before you, and would be pleased to clarify any confusion I may have created.

Mr. **Glickman**. Thank you. I don't think you have created any confusion at all.

Let me ask you just a couple of questions.

The Heritage Foundation, which is a think tank here in Washington, has recommended that NASA back out of aeronautical research and technology because private industry has sufficient incentive, that is through tax laws, patents, copyrights, whatever, to invest in innovation. How do you react to that?

Mr. **Armstrong**. That is an interesting suggestion. It's a little bit like asking the Congress to back off of legislation, however, and I'm sure there are some who would advocate that might be a good idea.

But certainly, a carefully reasoned analysis might indicate that Congress is in the business of legislation and NASA is in the business of research; and it is a job that it has performed extremely well over a long number of years with resources made available to it. And I certainly, in my own view, couldn't accept that kind of a recommendation.

Mr. GLICKMAN. You were involved in the NASA aeronautics budget for some time. If faced with big budget cuts—I don't think anybody on this committee is looking for big budget increases in NASA, I think we have tried to act as responsively as we can to insure that we don't reap any windfall when other sectors of the economy are suffering due to cuts in Government spending—do you think NASA should scale back in all areas or perhaps drop out of a single area, such as propulsion? Or how do you think we ought to face that issue if we have to cut back rather dramatically?

Mr. ARMSTRONG. Well, when times are short, across-the-board cuts are sometimes the most appropriate and equitable approach; when more time is available, more carefully reasoned surgery is appropriate. For my part, and within my experience, I believe that the Administrator of NASA is charged with the responsibility of directing his programs; and I think he should be given that responsibility, including the review and selection of program content, with the advice and the counsel of people in this Chamber.

Mr. GLICKMAN. What about the idea that the Defense Department take over NASA's aeronautics work?

Now, obviously, Mr. Weinberger doesn't like that idea; if I may read from his letter he wrote to David Stockman within the last few days:

> We have been advised that OMB is proposing major reductions in NASA's aeronautics program. We understand that this action will result in the closing of the Lewis Research Center and significant reduction in technical manpower. NASA aeronautics research facilities and technical capabilities have been, and will continue to be, critical to the development of military aircraft, such as the B-1-B, advanced technology bomber, next generation Air Force fighter and the Marine Corps transport-assault aircraft.

And he lists the serious concerns he has about this.

How do you feel about the military just taking over all aeronautical research and development?

Mr. ARMSTRONG. If there was evidence to indicate that NASA scientists and engineers were inept, then that would probably be a consideration that you all would have to consider. But I am not aware of such charges of ineptness; in fact, NASA, generally, is highly regarded for its skills and abilities. Consequently, taking programs from one agency and disbanding those teams that are doing that work, transferring it to another agency and building up teams to handle it over in a separate organization, it seems to me, would maximize the inefficiency to all concerned and provide no significant advantages.

Mr. GLICKMAN. Thank you.

Mr. Fuqua.

Mr. FUQUA. Thank you very much, Neil. And we appreciate greatly your coming and testifying. And I think your statement certainly outlines my feelings, also.

As Mr. Glickman pointed out, there are those who feel that private industry will pick up this type of research; and that this is an unnecessary expenditure of funds that could more adequately be done in the private sector.

Do you feel that the private sector would pick this up and that we would still be the leader that we are?

Mr. ARMSTRONG. We certainly have no evidence that that would be the case. During the period of the last—well, let's just say since the time I was a Deputy Associate Administrator of Aeronautics in NASA—during that time period there has been a steady erosion of resources made available to the aeronautical research program of NASA.

Now, if the supposition were correct, that industry would pick up the slack, they would have done so over that dozen years. But the facts are they haven't. As best I understand the statistics, industry R. & D. funding has declined at about the same rate as NASA's over that period. So, consequently, we have no evidence to indicate they would do so.

But to take that position disregards the historic Government-industry partnership that has existed over the years. Industry does provide a lot of its own research, and development, and technology development. As a matter of fact, it is significantly larger than NASA's aeronautical budget; many times over, I suspect. NASA's contribution is unique, in that it provides basic needs that are available to the entire industry and includes some $5 billion worth of facilities that would be available to all.

Mr. FUQUA. I agree, also, that as you pointed out that way back since World War I it has been a joint endeavor between industry and Government; and, I think, one that has worked very well, where there has not been Government interference, but where Government works hand in glove with industry in providing the necessary research and development activities that industry can then take and develop into products that they ultimately want to sell. And I think it is a good case of the adage: "If it ain't broke, don't fix it." And I think this "ain't broke."

Mr. GLICKMAN. Thank you, Mr. Chairman.

Mr. Dunn.

Mr. DUNN. Mr. Armstrong, I am a bit confused by some of the things I have heard here, and especially by the letter that the chairman referred to, suggesting reductions in funding for research and development.

One of the things that this administration talked about last year—with which I am in agreement—is that the Government should be concentrating on basic research, leaving commercial development and application to private industry. And yet, what is alleged here seems to be the opposite of that.

This is illustrated by the administration strongly supporting a budget of more than $4 billion for the Export-Import Bank—$4 billion. Let's put it in perspective: a strong $4 billion for Exim plus a vulnerable $280 million or $290 million for research.

In terms of the function that the Government should serve, what is your opinion of this use of Federal dollars? Aren't we better off, as the Federal Government, taking the $280 million out of that $4 billion budget, and keeping it in research?

It seems to me a better allocation of Government funds.

What is your thought on that?

Mr. ARMSTRONG. It is certainly an appropriate point. And I do agree with that perspective.

There is a fundamental difference in my view, that the kinds of things that the Export-Import budget handles are quite predominately short term; they have to do with sales in the next year or the next few years. NASA's budget is more long-range returns, and fundamental research will probably take more than 5, perhaps 10, or 15, years, to reap the rewards:

But I certainly would agree that it is very much like eating the seed corn.

Mr. DUNN. The Government says—

> We give you $4 billion to help you compete with other countries from abroad, but we don't give you 180 or 280 million to do the research that helps you compete better.

This seems confused.

Mr. ARMSTRONG. I agree. I believe a strong aeronautical budget would be consistent with the administration's stated objectives.

Mr. DUNN. I am a bit concerned of pulling the military into the funding picture. In NASA, we go beyond the needs of military aircraft—research for companies like Beech, the type of aircraft they make. If you look at the weak spots in our country's position as leaders in the aircraft industry, it is not in the big aircraft that we lack leadership, it is in the smaller, middle-line jets that serve some of the communities that the big airlines can no longer serve.

Mr. ARMSTRONG. It is certainly true, that within the civil aviation arena there have been major inroads by foreign competition. It is my perspective that from a technological standpoint, American products are still superior. However, the gap in that technological superiority has narrowed to the point where economics considerations and foreign government financing significantly affect the market share that the U.S. industry enjoys.

Mr. DUNN. I thank you.

Mr. GLICKMAN. Mr. Flippo.

Mr. FLIPPO. Thank you.

If there was one thing that we get from technology in this country, if there is one thing the Europeans and others look at, as to how effective, or important, or powerful the United States is, is there any other area more important than the aeronautics area? Isn't it one of the most visible means of conveying the power of the country to foreigners?

Mr. ARMSTRONG. Yes, sir. I would think that is certainly one of the highest profile items of American presence around the world.

We used to have other products that enjoyed that prestige. And many of those products, in recent years, have been superseded by foreign competition. And it would be my hope that we don't undermine the fundamental advantage we have in aeronautics by canceling or reducing our aeronautical research. It is, in my own view, the current efforts are about somewhere between two and four times too low.

Mr. FLIPPO. Thank you.

Thank you, Mr. Chairman.

Mr. GLICKMAN. Mr. Harkin.

Mr. HARKIN. Thank you very much, Mr. Chairman.

Mr. Armstrong, I would just like to ask you a little bit more of a technical type question than policy.

As I said in my remarks, we haven't flown higher, as Mr. Crossfield will tell you, since 1961. Have we reached a barrier? Is there some kind of invisible barrier out there, that we've done all we can in aeronautics and that's it? Have we bumped up against something?

Mr. ARMSTRONG. Well, that is a very reasonable question. There was a time when Mr. Crossfield and myself were bumping those barriers; but performance was the key goal that we were striving to achieve and surpass. Other goals have been merged over the intervening years. And now, the world over recognizes the requirement for efficient transportation, less energy-consuming transportation. And I think both foe and friend alike recognize the requirement to maintain a military presence and sophistication that will be the best in the world.

The challenges are many. There are many arenas that still require improvement: Efficiency is one, structures is one, new propulsion is a third, controls is a fourth. Those opportunities remain, and I hope we'll meet the challenge.

Mr. HARKIN. I see them as opportunities, also. I have been one of those who, to the consternation of many of my friends—not on this subcommittee, but in Congress—have been a very vocal proponent of continuing our research and development base for the supersonic transport. I've said many times, if we can develop a supersonic transport that is fuel efficient, where the seat miles per gallon is not too far out of line, where the cost is within the reach of the average, or at least most travelers, and one that is environmentally acceptable—that is in terms of noise levels and pollution levels—that we ought to move ahead with it.

As we look around the world, we know that in the next decade Brazil is going to be one of the major world powers. I believe Australia will be coming along. Certainly, Japan will maintain its posture in that regard. China will be coming onboard in the next 10 to 20 years, as a major world power in terms of its commerce. And all of these countries are great stretches across the ocean. And we will need a supersonic transport to get there quickly.

But the technology base that we were working on for the development of a supersonic transport is being eroded. You just mentioned propulsion. The new engines that we were working on, the variable-cycle engine, for example, is now dead in the water.

I guess what I am reaching for is that the only barriers that are out there are barriers that we put up for ourselves? And to the extent that we put those barriers up, we tend to withdraw, and we say, "Well, we just can't face that, we can't break through those invisible barriers."

But if we begin to erode that base now, then we're just never going to get anywhere, we're never going to get any further than the 727, or 707, or DC-10, or anything else; that is going to be where we are in this country. Now, whether or not other countries will do it or not, I don't know.

I know that is not much of a question, it is more in terms of a statement. I just wondered if you had any clarifying comments on what I just said about that process that we are now engaged in, of cutting out the research and development base for future supersonic transports.

And I don't even know what your position is on the supersonic transport. I don't want to get you into that argument.

Mr. ARMSTRONG. Well, I'll give you my opinion on that. I think supersonic transport is too small and too slow.

Mr. HARKIN. All right. That's true.

Mr. ARMSTRONG. Those are appropriate observations, in my opinion. We have, over a period of, roughly, half a century, a little over half a century, developed a very effective partnership between the Government, and the industry, and the military. And it has served us well.

In the absence of evidence to indicate that it is failing to serve us, and shows no promise of providing returns proportional to the investment consistent with our past experience, I would urge this committee and all of Congress to support an active and strengthened aeronautical research program.

Mr. HARKIN. Just one last thing, tradeoffs.

There are those that propose we put more into the slower higher-lift, short-field aircraft, and forget about the long-range supersonic. I don't see it as a tradeoff.

What are your feelings on the slower aircraft, the more high-lift aircraft, the shorter field landing and takeoff aircraft?

A great deal of effort has been put into that.

Mr. ARMSTRONG. Mr. Harkin, all of us have favored projects and arenas in which we have specific interests, concerns, beliefs, and hopes. In general, those concerns and hopes are valid. Realities dictate that we can't do everything, and someone has to make the judgment as to which opportunities will be pursued. For my part, I am very satisfied, feel very comfortable, with the arrangement that allows NASA management to consult with the military, industry, and this Congress to make those decisions.

Mr. HARKIN. Thank you very much.

Mr. GLICKMAN. Thank you, Neil. We appreciate your testimony.

Mr. ARMSTRONG. Thank you, Mr. Chairman.

Mr. GLICKMAN. We appreciate very much your testifying here today.

Mr. ARMSTRONG. It is my pleasure. Thank you very much.

Mr. GLICKMAN. Thank you.

One of our witnesses will not be able to appear today. He has had an accident, actually, this morning—General Slay. He was scheduled to testify as the fourth witness.

Our next group of witnesses is a congressional panel, all very esteemed Members of Congress from the Cleveland area. And I would like them all to, come to the table: Congressman Ron Mottl, from the 23d District of Ohio; Congresswoman Mary Rose Oakar, from the 20th District of Ohio; and our former colleague on the full committee, Congressman Don Pease, from the 13th District of Ohio.

I have always heard that Ohioans were special for football and for aeronautics, so we are glad to have you all here. And perhaps if you want to proceed in the order of Mottl, Oakar, and Pease, that is the way it is listed—that is alphabetically—that is probably as reasonable as anything else.

And you may feel free to summarize as you deem appropriate. Your entire statements will appear in the record.

STATEMENT OF HON. RONALD M. MOTTL, A REPRESENTATIVE IN CONGRESS FROM THE 23D DISTRICT OF OHIO

Mr. MOTTL. Thank you very much, Mr. Chairman. I think each one of us is probably going to hit a different aspect of why Lewis is so important to the Greater Cleveland area, and also to the Nation.

And I, for one, would like to thank you for the opportunity to testify at this important hearing this morning. The Lewis Research Center borders on my 23d Congressional District, and many Lewis employees are my constituents. I don't think I need to dwell on the quality of the people at the Research Center or the contributions that they have made to the greater Cleveland area—scientifically, technically, culturally, or in a variety of other ways. But I might add at this point, Mr. Chairman, that I think Lewis the think tank is as important to the Nation and greater Cleveland as the Cleveland clinic and the Cleveland orchestra. They all have made invaluable contributions nationally and locally.

I would like to emphasize Lewis' unique capability, in my testimony, and focus on the role that the Center has had in energy research and development. I think it is safe to say that their performance in carrying out supporting research and managing federally sponsored programs in energy R. & D. has been outstanding when compared with any other institutions which have similar responsibilities for Department of Energy programs.

The Lewis involvement in energy R. & D. dates back to the Nixon administration, when the Wakefield committee was formed to outline an energy R. & D. program for the Nation in the wake of the Arab oil embargo. The product of this committee was the outline of the program responsibilities for the then to-be-created Energy Research and Development Administration [ERDA] which was the R. & D. predecessor of the Department of Energy.

The Lewis director at that time was Bruce Lundin, who served on that committee; and afterwards, there was significant interest in obtaining the Center's participation in managing energy R. & D. programs. I should point out that the presence of Atomic Energy Commission personnel at high levels in the newly created ERDA and the unfamiliarity of groups such as the office of Cal Research, from the Department of the Interior, with the Lewis capabilities, made it extremely slow and painful for this Center of problem solvers to convince people of the significant role they could play. This was the case, despite the fact that their traditional Government role as a partner with the industry in developing the technology base for advanced aircraft engines was a natural model for the ERDA, and then Department of Energy, to employ in pursuing energy R. & D. with industry.

The Center, after much effort, obtained a significant responsibility in energy programs, such as heat engine development for automotive and stationary sources in conservation, advanced turbine development in fossil energy, wind power and solar cell applications, as well as specific assignments in the fossil program, for example, MHD power generation and the advanced clean-burning technologies for coal, as I mentioned.

More recently, the Center was given lead responsibility in high technology programs for industrial conservation. In all instances, Lewis has played the classic Federal role of providing outstanding management skills while working with industry to accelerate technology development through high risk activities while keeping the Federal administrative burden to a minimum. Lewis spends, on the average, only 20 percent of the dollars it has managed in-house, and proved as a catalyst to industry in getting the job done while allowing flexibility in carrying out projects.

Many of these energy programs have been cut back considerably by the Reagan administration. And, in this context, I would like to call your attention to a specific program which the administration wishes to terminate: Lewis' automotive research and development in advanced heat engines. I would like to take a minute or two to explain to you why I consider this action ill advised and not in this country's best interest.

The proposal that the Center's role in aviation be discontinued, I simply consider unacceptable, and can assure you that we will fight it as an Ohio delegation.

The Lewis Center is known worldwide as a gas turbine center of excellence. In fact, it is often referred to by industry as the world's gas turbine technological university. The great reservoir of knowledge and experience here dates from Lewis' first turbine work in support of the jet engine development in the 1940's. As you know, the British built the first jet engine, but this Center is chiefly responsible for providing a superior technological base such that most of the jet engines sold today around the world are U.S. built.

The Center succeeded in developing a partnership with several elements of the automotive industry, despite initial suspicion aggravated by the fact that that industry's chief experience with the Government has been previously confined to the usually unpleasant regulatory arena. Despite this difficulty, Lewis has succeeded in carrying out cooperative programs with Chrysler, Ford, and the Detroit Diesel Allison Division of General Motors. These programs have led to a variety of applications from ceramic components in gas turbine engines to more aerodynamically efficient turbines for these engines.

The development of improved Stirling heat engines and a theoretical base for describing behavior of a variety of other advanced heat engine components and systems has been developed at this lab. In addition, the Center has made contributions in helping develop advanced components for electric vehicles, including motors and controllers, in cooperation with companies such as Chrysler and Air Research.

I think it is fair to say that their contributions across the spectrum of automotive R. & D. have been impressive and, I believe, will result in a great payoff in the coming decades in terms of better working parts which last longer in much more efficient engines. I cannot believe that Mr. Stockman or his friends at General Motors are shortsighted enough to feel that this activity should be terminated.

I have been active over the past year and a half in trying to encourage a broader role for NASA in automotive research and development. Let's face it, the automobile industry is on its back; and given the cost of today's money, there is no incentive for them to do the very risky kind of component development through which Lewis has proven itself.

I would like to close by saying that the economic recovery is commendable when it really gets Government off our back. But the Lewis Research Center hasn't been on anybody's back. In fact, the Center has clearly given industry and the military a ride for decades; and that is their proper role. Let's keep this Center strong as the corporate memory for this high technology.

Mr. Chairman, I would also like to share with the subcommittee at this time, if I may, a letter that I got from one of my constituents by the name of Curtis Walker, who is a resident of my district and an employee. And if I just can read a couple of paragraphs in conclusion here, it says:

> Dear Mr. Mottl, By way of introduction, I am an aeronautical engineer working on the helicopter engine research. I am employed by the U.S. Army Propulsion Laboratory at NASA, Lewis Research Center, engaged in joint Army-NASA research projects.
>
> I am concerned over the rumors of a cut back at Lewis, and if it were to occur, its effect on the future of Army aviation. I believe that NASA management may not have made you aware of the contribution of NASA facilities, personnel, and service to the U.S. Army Research and Development Command and our joint contribution to the aeronautics propulsion technology. Therefore, I want to develop for you the background of this joint arrangement.

And it recites here the history of how important the research at Lewis has been to the Army aviation program, the helicopter p [illegible] gram, and other important Army programs.

I would like to submit this into the record, because I think it i [illegible] extremely important to show the contributions that Lewis has made, not only for the automobile industry, but also for the Army, and also, as we all know, the cyclotron for cancer research and other medical instruments for cardiacs. This great think tank has made a great contribution, not only to the Nation but to greater Cleveland. And we would implore this committee to continue its budget and not cut one penny from it.

Thank you very much, Mr. Chairman.

Mr. GLICKMAN. Thank you very much, Mr. Mottl.

Without objection, the letter from your constituent will appear at the end of your statement.

Mr. MOTTL. Thank you.

[The letter follows:]

BAY VILLAGE, OHIO, *December 3, 1981.*

Hon. RONALD M. MOTTL,
House of Representatives, Washington, D.C.

DEAR MR. MOTTL: By way of introduction, I am an Aeronautical Engineer working on helicopter engine research. I am employed by the U.S. Army Propulsion Laboratory at the NASA Lewis Research Center engaged in joint Army/NASA research projects. I am concerned over the rumors about a cutback at Lewis and, if it were to occur, its effect on the future of Army Aviation. I believe that NASA managem [illegible] may not have made you aware of the contribution of NASA facilities, perso [illegible] and services to the U.S. Army Research and Development Command and our joint contribution to aeronautics propulsion technology. Therefore, I want to develop for you the background of our joint arrangement.

1. During the mid to late 1940's, with the formation of the three military servi [illegible] under the Department of Defense, primary responsibility for aviation researc [illegible] development was assigned to the Air Force. In spite of its unique needs, t [illegible] was required to rely on the Air Force to develop and procure its aviation [illegible] helicopters and light observation aircraft.

2. By 1960, it became apparent that the Army's role in aviation and associated combat support had grown by necessity and a separate command was organized to concentrate on these expanded needs. This new command, now known as the Aviation Research and Development Command (AVRADCOM), was headquartered in St. Louis, Missouri and given the mission to provide the Army with maximum affordable technology for aviation systems, support materiel readiness, and conduct the materiel acquisition program.

3. Although this role in aviation was not new to the Army, it lacked facilities and equipment necessary to conduct a supporting research program. One way to establish the needed capability was to acquire, equip, and staff new facilities, but it was evident that the cost for such a series of steps would be prohibitive. Yet, the Army urgently needed to develop a strong core of technology specialists—first, to conduct its technology programs and second, to become intelligent buyers of new systems. Both demanded an aggressive, innovative team with "hands-on" know how, which could only come from a modern laboratory environment where these skills could be nurtured.

4. The need continued to grow with Army systems requirements in rotory-wing and small, fixed wing aircraft. By 1965, a decision was reached to establish the capability by teaming with an already-recognized government aerospace laboratory organization. On that basis, an agreement was reached with the National Aeronautics and Space Administration to conduct joint research in areas of mutual interest, starting with programs in helicopter aerodynamics at the NASA-Ames Research Center. Based on the successes achieved in that relationship, the agreement was expanded in 1970 to include structures research at NASA Langley and propulsion research at the NASA Lewis Research Center. These Army organizations now make up the Research and Technology Laboratories (RTL) of AVRADCOM.

With this as background, it is stated that the gains in Army Aviation since the mid 1960's could not have been made without this strong support from NASA. Each of the laboratories, Aeromechanics, Structures, and Propulsion, has developed its own specialists and can point with pride to a long list of contributions to aeronautical technology made with direct assistance from NASA. The articles from Army Aviation are enclosed to provide you with more information about the Army Aviation Laboratories.

Now, more specifically addressing the impact of a potential roll-back at the NASA Lewis Research Center, the joint Army/NASA activity is an essential part of the Aviation Research and Development Command. The savings from this unique arrangement amount to several million dollars each year because of sharing resources to reach a common objective. Each organization brings to the programs its technology specialists, equipment and dollars. NASA brings one more vital asset to the programs—its priceless facilities. Without this access the Army would be forced to find an alternate arrangement to preserve the capability. Unless funds could be made available for that purpose and unless NASA's current role at the Lewis Research Center is sustained, the hands-on expertise will be lost and the entire concept of support for Army Aviation will have been erased. Clearly, the Army would need to replace this lost capability, and rebuilding a laboratory team would be wasteful and extremely costly in time and dollars. The Army would have to do it all over again . . . . team with another partner.

The alternatives at the Lewis Research Center are simple, and there are only two that can be considered workable to the Army. One is to maintain a strong NASA program in aeronautical propulsion that will permit the Army to continue in a joint role. The second is to provide the Army with resources to operate portions of the Center facilities important to its mission in aviation. Eliminating both of these alternatives is tantamount to having no viable option.

The purpose of the forgoing is to familiarize you with this Army activity. Although the 55 or so Army employees are greatly outnumbered by their NASA peers, the importance to Army aviation and the Nation cannot be overemphasized.

The concept of mutually-supported joint programs is an important money-saving way of meeting military and national needs and should be supported and expanded. It should be viewed as a "wave of the future"—an ideal way for the government (in this case, the Army and NASA) to maximize the return on each dollar spent. We do not work alone and we do not compete with each other. Our strength is in working together where the facilities are located.

Respectfully,

CURTIS L. WALKER.

Mr. GLICKMAN. Congresswoman Oakar.

STATEMENT OF HON. MARY ROSE OAKAR, A REPRESENTATIVE IN CONGRESS FROM THE 20TH DISTRICT OF THE STATE OF OHIO

Ms. **Oakar**. Thank you very much, Mr. Chairman and members of this distinguished committee. I am very, very proud to be joining my colleagues from Ohio, including Neil Armstrong, who is not only a source of pride to Ohioans but to the Nation. And it is my understanding that his career at Lewis Research Center was in the field of aeronautics.

I want to thank you, Mr. Chairman, for having this hearing. I think that it is a great service to all of us to get this whole issue in the open before we regret some of the cuts that may take place.

Mr. Chairman, with your permission, I would like to submit for the record Senator Howard Metzenbaum's brief testimony—he is unable to be here; and a letter that the entire Ohio delegation wrote to the President.

As you may be aware, I chair a task force for our Ohio delegation, a bipartisan task force, to save Lewis Research Center. And I want to assure members of this committee that we stand ready to form a coalition to save the entire NASA project across the country.

Mr. **Glickman**. Without objection, all of the documents will appear in the record as part of your statement.

Ms. **Oakar**. Thank you very much.

[The statement and letter mentioned above follow:]

U. S. Senator Howard M.

METZENBAUM

of Ohio

Committees
Budget
Energy and Natural Resources
Human Resources
Judiciary

CONTACT: Roy Meyers
202 224 2315

FOR IMMEDIATE RELEASE
December 8, 1981

STATEMENT OF SENATOR HOWARD M. METZENBAUM

BEFORE THE HOUSE SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

December 8, 1981

I am grateful to you, Mr. Chairman, for giving me this opportunity to speak on behalf of sustaining NASA's vitally important research and development activities.

We hear a great deal of talk nowadays about the need to modernize our economy.

We see on our highways and in our living rooms the practical impact of the innovations that other countries have made in industries, like autos and television, that once were dominated by American companies. And we know, Mr. Chairman, that in the future, foreign competition in virtually every area is certain to grow stronger.

For that reason, I do not believe that it makes any sense at all to cripple a vital part of this nation's scientific and technological base in order to make a short term "savings" that will make David Stockman's bottom line look a little bit better. At a time when countries like Japan, Germany and the Soviet Union are pouring resources at an unprecedented rate into basic research, we see in this country short-sighted budget proposals that threaten to fritter away our tenuous lead in the industries of the twenty-first century.

In my own state, Mr. Chairman, we have in NASA's Lewis Research Center in Cleveland an example of what we stand to lose should NASA's R and D budget be cut in the next fiscal year. A massive cut could mean that NASA's Lewis facility would be forced to close.

The Lewis Research Center has distinguished itself for its fine work in developing methods for curbing aircraft noise and lowering fuel consumption. It is the only government facility involved in aeronautic propulsion systems and as such, it has provided invaluable assistance and information to private companies involved in this innovative and complex area. It has been estimated that Lewis research alone has contributed to more than $13 billion in sales of U.S. made aircraft to foreign countries.

The Lewis facility is also a pioneer in research designed to improve the fuel efficiency of automobile engines. Ultimately, that research will contribute directly to reducing our dependence on foreign oil and to turning around a disastrous situation in which we're exporting 400,000 jobs and importing foreign engines worth $5 billion a year.

The Lewis facility is important to the nation. But it is also important to the State of Ohio and its citizens. More than 2,700 people are employed directly at the Center. More than 4,000 other jobs are tied to Lewis. And each year, the facility is worth more than $125 million to the economy of the Greater Cleveland area. It goes without saying that the effects upon the city and the state of closing this vital facility will be truly devasting, especially at a time when Ohio's unemployment is running at over eleven percent.

An editorial in the December 6, 1981 edition of the Cleveland Plain Dealer stated, "...it would be foolish and false economics to shed a priceless asset for a temporary gain in the ledger."

I sincerely hope that Congress and the Administration recognize the truth in this statement and provide adequate funding for some of the most productive research being done in this country today.

end

Congreſs of the United States
House of Representatives
Washington, D.C. 20515

November 17, 1981

President Ronald Reagan
The White House
Washington, D.C. 20500

Dear Mr. President:

We are requesting your immediate assistance in a matter of grave concern to the people of ~~the~~ State of Ohio regarding the future of the Lewis Research Center in Cleveland, Ohio.

It is our understanding that the Office of Management and Budget has under consideration the closing of the Lewis Research Center as part of the additional 12 percent cut in Fiscal Year 1982 budget authority that NASA has been instructed to make in its programs. Whatever nominal cost-saving could be realized from the closing of Lewis Research, the indisputable truth is that Lewis' closing would be our country's loss in the fields of aeronautics, space, and energy where Lewis has distinguished itself as an international leader.

Located in Cleveland, Ohio, Lewis Research Center employs 2,700 highly skilled men and women and has an annual budget of almost half a billion dollars. Lewis Research is responsible for generating thousands of support service jobs as well as millions of dollars in income and tax revenues for the State of Ohio. Closing Lewis would thus deprive the State's economy of these needed income and tax dollars and would impose a severe drain on Ohio's unemployment insurance trust fund, perhaps necessitating additional borrowing by the State of Ohio from the Federal Government.

Lewis Research is deeply involved in the development of superior fuel-efficient automobile and aircraft engines and in the design of such energy-conversion technology as a wind machine that uses wind power to produce electricity.

As our country and the rest of the world marvel at the most recent triumph of 'the Columbia space shuttle, we might do well to remember that Lewis Research has played a key role in the research on the kind of propulsion system used to power the Columbia into earth orbit.

Mr. President, we are on the brink of exciting new discoveries in the exploration of space -- discoveries that will be for the good of all mankind. With this in mind, how can there be any consideration given to the closing of a facility like Lewis Research whose technological breakthroughs in the conquest of space are second to none?

As part of NASA's Technology Utilization Program, Lewis Research has achieved unparalleled success in transferring its technological know-how to a broad and diverse range of human needs, such as communications, computers, transportation, home appliances, food products, and medicine. In medicine, for example, Lewis has developed the technology for more effective radiation treatment of patients suffering from serious disease. This kind of transfer technology improves the quality of our lives and enriches the productive energies of our people.

Mr. President, we, the Members of the Ohio Congressional Delegation, strongly urge you to reject any option or proposal that entails the closing of the Lewis Research Center. In view of Lewis's significant and internationally acclaimed achievements in aerospace, energy, and transfer technology, and in view of Lewis' critical contribution to the economy of the State of Ohio, we wholeheartedly recommend that Lewis Research remain an open and active facility. Your support in this matter would be most appreciated.

Thank you for your favorable consideration and response.

Sincerely,

John Glenn
John Glenn
U.S. Senator

Howard M. Metzenbaum
Howard M. Metzenbaum
U.S. Senator

Mary Rose Oakar
Mary Rose Oakar
Member of Congress

John Ashbrook
Member of Congress

Tony P. Hall
Tony P. Hall
Member of Congress

Delbert L. Latta
Member of Congress

Clarence Brown
Clarence J. Brown
Member of Congress

Louis Stokes
Member of Congress

Clarence Miller
Clarence E. Miller
Member of Congress

Chalmers P. Wylie
Member of Congress

Bob Shamansky
Robert N. Shamansky
Member of Congress

Michael Oxley
Member of Congress

John Seiberling
John F. Seiberling
Member of Congress

William Stanton
J. William Stanton
Member of Congress

Ralph Regula
Ralph S. Regula
Member of Congress

Ron Mottl
Ronald M. Mottl
Member of Congress

Dennis E. Eckart
Member of Congress

Bob McEwen
Member of Congress

Ed Weber
Ed Weber
Member of Congress

T. A. Luken
Thomas A. Luken
Member of Congress

Donald J. Pease
Member of Congress

Ms. Oakar. The contributions of Lewis have been a source of strong local, regional, and national pride for more than 40 years. Today this wonderful Research Center employs 2,700 highly skilled men and women, and it generates thousands of support-service jobs as well as millions of dollars in income and tax revenues for the State of Ohio. So, needless to say, it is a very, very valuable asset not only to our area but also to the country.

My appearance here today reflects my serious concern about Lewis Research Center, which is located in my congressional district. For this reason, Mr. Chairman, I applaud your decision to have this hearing, and I must say I was very heartened by the Secretary of Defense Weinberger's letter indicating how valuable NASA is to complement the work that is done in our Defense Department.

Federal laboratories like Lewis are designed to carry out activities that are high risk and too expensive for industry to undertake by itself. Also, the Government should do those things that require unique facilities involving such a large investment that they cannot readily be duplicated or the combination of expertise and facilities cannot be copied. And, I must say, other countries in the world have a healthy complement of government working with private industry, and they are doing it very, very successfully; and so are we. It would be tragic to end that kind of complement.

I also believe that Federal labs should perform activities on the basis of national interest. Private sector incentives to do such research and development simply do not exist. I have always felt that federal laboratories such as Lewis constitute unique national resources in terms of available expertise and physical plant capability for doing such high technology work. At a time when all Americans desire our great country to be No. 1 in technology and national defense, it would be unbelievably ironic to close this internationally acclaimed center.

This morning I want to concentrate on something that I know is especially interesting to your committee, Mr. Chairman, and that is Lewis' contributions, primarily, to the U.S. aeronautical effort; and to touch on areas such as energy, space, and transfer technology. Aeronautical propulsion has been the mainstream effort at Lewis since its beginning. The main objective of the Lewis aeronautical program is to provide technology that will make for safe, more economical, more efficient, and more environmentally acceptable air transportation systems. Lewis plays a critical role in our national defense effort by supporting the Air Force in maintaining a technology base for developing superior military aircraft. Let me simply stress that the Lewis Center carries out vital national defense responsibilities that cannot be assumed by the military , especially in aviation. And, obviously, Secretary Weinberger's letter confirms that.

Because the Defense Department is motivated primarily by immediate military needs and requirements, it cannot become involved in long-term research and development to the extent that Lewis Research can. It is precisely because Lewis has the necessary freedom and flexibility to engage in long-term research and development that makes it so essential to the development of technology to meet our national defense needs. Thus, Lewis fulfills an important purpose by relieving the military of the responsibility to invest limited manpower and resources into advanced research and development on defense-related technology—a purpose that Lewis fulfills admirably with its highly skilled scientists, engineers, technicians, and other personnel.

The Lewis mission in aeronautical propulsion has led to the development of special laboratory skills in physical, chemical, mechanical, metallurgical, electrical, and electronic research, and has resulted in a number of large facilities to simulate the environment in which an aircraft engine or spacecraft power system must operate. The total investment over a period of years in the physical plant is $300 million, including the new National Computer Center established at Lewis last year, due in part to the help of this committee. The physical plant has an estimated replacement cost of over $1 billion.

Mr. Chairman, Lewis Research has compiled an impressive record in major technical accomplishments in aviation and space since the ground for the center was broken in 1941. I think it is worth mentioning that in 1981, Lewis' large wind energy systems received the 33d prestigious IR-100 award, which has been made to this Center since 1963 by Industrial Research Magazine, a very distinguished magazine in the industry. Only a handful of industry groups and no Government organizations can match this record. Lewis' aeronautics, space, and energy programs are supported by an advanced materials capability that is unique in the free world.

Since we are discussing an agency decision that must be made in the 1980's, I think it is worthwhile to enumerate some of the major aeronautics efforts which the Center has been engaged in through the last decade. The aeronautics work has included a partnership—and a healthy one—with General Electric and Pratt-Whitney on the development of superior, fuel-efficient aircraft engines for the existing commercial airplane fleet. Lewis has looked at new ways to power vertical and short takeoff commercial and military aircrart and studied new concepts for advanced components, including compressors and turbines for military and civilian engines not yet on the drawing boards. At the same time, the Center's staff is developing ways of testing new materials under conditions that are not yet a reality for commercial or military engines.

In short, Mr. Chairman and members of this committee, the Lewis Center is on the frontier of aviation, and no private engine company can afford this high-risk work or—I might add—have the expertise to match the unique in-house capability which this Center possesses.

Lewis Research has played a critically important role in the research on the kind of propulsion system used to launch our space shuttle, the Columbia, into Earth orbit. The same propulsion technology also made possible the safe return of the Columbia to its picture-perfect landing. Certainly, as the rest of the world joins us in marveling at these breathtaking triumphs in our exploration of the boundaries and mysteries of space, we should give all of the support we can to a facility such as Lewis whose contributions to our country's achievements in space have so long been the source of national pride and the object of international applause.

Indeed, it is in our country's best interest to continue these types of programs.

In the area of energy conservation, Lewis has been actively engaged in the design, development, and testing of the Stirling engine, an advanced automotive engine that promises significant fuel savings, superior to that of today's conventional internal combustion engine. During 1981, the first automotive Stirling engine was tested and all engine performance goals were met or surpassed. A second generation Stirling engine is projected to provide a 50-percent improvement—50-percent improvement—in fuel economy over the conventional spark-ignition system it is designed to replace.

At a time when we are involved in a serious national effort to develop alternate forms of energy and lessen our dependence on uncertain and expensive sources of oil, it makes little sense to discuss the possibility of closing this facility whose contribution to energy conservation in its work on this type of engine and other projects has been enormous.

As part of NASA's Technology Utilization Program, Lewis Research has achieved unparalleled success in transferring its technological expertise to a broad and diverse range of human needs, such as computers, communications, transportation, home appliances, food products, and medicine. In bio-medicine, for example, Lewis Research has developed a cyclotron used by the internationally acclaimed Cleveland Clinic for the radiation treatment of patients suffering from cancer and other serious diseases. And we know that this kind of medical procedure—which has proven to be so successful—will be used to treat future cancer patients. More than 230 patients have received this treatment, and I might add that 80 percent were from outside of our county. This kind of transfer technology as developed by Lewis improves the quality of our lives and enriches the productive energies of our people.

Mr. Chairman, I do not consider any budget cuts which may be proposed for NASA for fiscal year 1983 to be in the national interest. To emphasize this point, let me say again how delighted I am that you were able to apprehend the letter from Secretary Weinberger. Hopefully, this letter will be part of our record here for this wonderful committee. Neither do I think that NASA's work can be turned over to the military—which has been rumored for many weeks. Therefore, any proposal whose purpose or effect would be to terminate Lewis Research Center suggests a serious lack of understanding of Lewis' vital role in aviation, energy, space, and transfer technology research, and creates a dangerously distorted perception of our basic national security needs and interests.

And just as Ron Flippo's subcommittee came to Lewis Research Center—and, indeed, I believe other members of the committee have been to Lewis Research Center and toured that facility—I would like to personally invite, as a representative from the district, not only this committee but the President of the United States and the members of his Cabinet, to come out into the field and tour this outstanding center. It is a source of national pride and a beacon of the highest form of technology research and development found anywhere in the world.

I want to thank you very much for the opportunity to testify, Mr. Chairman. And I think that if we are united as a coalition of Members of Congress who are interested in maintaining our number one status in technology and our strong national defense, we can not only save our center but other areas of the country in the field of research done by NASA. Thank you very much.

Mr. GLICKMAN. Thank you, Mary Rose, for that excellent statement. Our colleague, Don Pease.

STATEMENT OF HON. DONALD J. PEASE, A REPRESENTATIVE IN THE CONGRESS OF THE UNITED STATES

Mr. PEASE. Thank you very much, Mr. Chairman. It is a pleasure to return to the Science and Technology Committee, if only for a brief time.

I would like to thank you and my colleagues for the opportunity to testify and for your wisdom in convening a hearing of what I think is really a matter of critical importance to our country. I think it is important not only from the point of view of the stakes involved, but the future of an excellent research center and its unique people, its expertise and facilities, but also a key hearing for the technological future of our entire country.

We are all familiar with the contributions that NASA has made to civilian technology, including their specific support in the civilian aircraft industry, which has already been covered, in providing technology for more efficient, environmentally acceptable, and more reliable air transportation systems. In addition, NASA has made a valuable contribution to energy research and development, in which they have performed as a model Government laboratory in managing programs and projects, as well as carrying out their technical expertise.

The long-term stakes that the U.S. has in maintaining a strong civilian R. & D. capability in aircraft and space propulsion and power are evident today, Mr. Chairman. I should like, however, to address my remarks principally to the history of Lewis Research Center support from the military and the strong argument for maintaining such a separate civilian capability. If there is anything that the current administration stands for, it is the strengthening of our national defense capability. It would seem to me tragic, in light of those goals on the part of President Reagan, to cut back and even close a facility which has contributed so much to national defense over the years. I would hope that all of your witnesses would support the Government role in aeronautical research, in technology development, since this role has been outstandingly successful.

As you know, my district, the 13th District of Ohio, is adjacent to the district of Mary Rose Oakar which contains Lewis. And many of my constituents are employees at the Center. In addition, my district contains the Center's Plumb Brook Station near Sandusky, Ohio, which has the unique space-testing facility, one of which is used in support of the Department of Energy's gas centrifuge program for uranium enrichment.

I have made a considerable effort in having these facilities utilized by other agencies, as did my predecessor, Mr. Charles Mosier, former ranking Republican on the Science and Technology Committee. From this perspective I have become particularly interested in the NASA-Lewis research role in supporting the military in aviation and space. And I think it is worthwhile to provide you with a summary of that involvement and explain the nature of that role.

As you know, the NASA-Lewis role in the 1940's was to provide a technology base for advancement of U.S. jet engine technology. And the Center achieved an outstanding track record in carrying out that mission. Congresswoman Oakar has addressed specific aspects of the Center's role in support of civilian aviation over the past few decades, so I shall concentrate on what has been done for the military science 1950.

In the 1950's, Lewis did pioneering experimental and analytical work on high-energy fuels for military application, especially hydrogen. And this work was requested by both the Air Force and the Navy. In addition, Lewis did the main technology work for high-speed turbo jets and ram jets for manned aircraft to missiles for both services. Then, the National Advisory Committee on Aeronautics [NACA], and the military, worked closely on this early research.

I don't think you have to be a member of the Armed Services Committee or an expert of the Department of Defense to appreciate the importance of these efforts to our national defense in years past. The experience in fuels greatly aided the development of 1960 spacecraft. In the 1960's, the Center fulfilled one of its classic roles by providing independent evaluation of various industry concepts for air-breathing, single-stage-through-orbit booster, and that was done for the Air Force.

I should point out, Mr. Chairman, that only Lewis had the capability and the objectivity to provide an unbiased analysis of these approaches; so that the Air Force was not at a disadvantage in terms of technical assessment.

The Center, along with Langley Flight Center, also conducted a major set of studies, called the FX series, at the request of the Air Force, to provide an independent set of design and performance estimates for the next generation of fighters and engines. This important work contributed greatly to the design definition of both the F-15 airplane and the F-100. And I might interject that only last Friday, as late as then, did I go to Lewis on another mission, and happened to see the testing facilities for the F-15 engine.

Other significant military activity at this time consists of studies and a component technology for a long-range logistic airplane aimed at ultimately replacing the C-5-A. And, as you know, that effort is critical if we are to have the rapid deployment force, which is a cornerstone of the administration's Middle East policy.

It was the main propulsion and power center for this period, when the development of rocket engines and other space-related hardware work during the late 1960's and through the 1970's consisted of efforts including the revival of the work to extend the technology base for improving aircraft engines, as well as work on alternative propulsion systems for the Navy's subsonic fighter. Lewis was able to predict the effects of varying all of the important engine design parameters. The early 1970's brought a major request from the Army in helicopter propulsion to perform life-cycle clock settings in various types of propulsion systems for advanced utility helicopters.

Lewis has continued its support of the Air Force by studying, for example, current tactical proposals for the utilization of compressor water injection for stress augmentation on the F-16 fighter. Generally, during this return to aeronautics, the Center concentrated on problems in common with the turbofan engine under subsonic and supersonic flight conditions.

Mr. Chairman, I think it is acknowledged that military experts around the world, and certainly indicated in the sales of aircraft, that the F-15 and F-16 fighters of the United States are considered the best aircraft of their kind in the world. That doesn't happen automatically. We have to worry about what is going to be the best aircraft for the world 5, or 6, or 10 years from now. The research at Lewis, which they have been doing, will help in the future to provide and to maintain that leadership.

Now, Mr. Chairman, I have tried to briefly summarize the Lewis contribution over the past quarter century. In that period, the Center performed tests in the Department of Defense, in the aircraft and missile systems, in its truly unique facility. And I shall include a list of those individual tests for the record if that meets with your approval.

Mr. **Glickman**. Without objection.

[The information follows:]

Space Administration

NASA

Lewis Research Center
Cleveland, Ohio
4413

to Attn of 2010

November 17, 1981

TO: 2300/Russ Keller

FROM: 2010/Chief, Mission Analysis Office

SUBJECT: LeRC Military Support

REF: Memo from Bill Dey dated November 6, 1981

Given below are a number of Lewis programs that supported the DoD, with emphasis on the work of this Office. They are coded into these categories:

A - specifically requested by a DoD group
B - coordinated/discussed with a DoD group
C - military-focussed but not specifically requested

1950-1960

- Experimental and analytical work on high-energy fuels for military applications, especially hydrogen and boron (USAF Navy; A/B)

- High-speed turbojets and ramjets for manned aircraft and missiles (USAF, Navy; A/B)

1960-1970

- Aerospaceplane studies (USAF; A)
  Independent evaluation of alternative concepts for air-breathing single-stage-to-orbit boosters.

- F-X studies (USAF;A)
  Joint Lewis/Langley major study to offer an independent design and performance estimates for the next-generation fighter and engine; contributed to definition of the F-15 airplane and F-100 engine.

- Nuclear-powered airplane (USAF; B/C)
  Studies and component technology for a long-range logistics airplane to succeed the C-5A.

1970-1976

- Navy fighter studies (Navy; B)
  Studies of alternative propulsion systems for supersonic fighters; showed effect of engine design parameters.

- Helicopter propulsion (Army; A)
  Life-cycle cost study of various types of propulsion systems for a utility helicopter

- Water-injection (USAF; A)
  Study of a contractor's proposal to use compressor water injection for thrust augmentation on the F-16.

1976-1981

- VTOL-A (Navy; A/B)
  Studies of propulsion systems for the subsonic Navy VTOL airplane. Specifically, supported the Lewis Lift-Fan Project Office to compare gas-drive vs. shaft-drive for the joint Navy/NASA RTA program, which finally was dropped.

- Engine analysis (USAF, Navy, ~~Army; A)~~
  Provide computer codes to 8 DoD groups plus many of their contractors, including follow-up support and advice on use.

- Cruise missile propulsion (USAF/SAB; A)
  Provide technology assessment to Scientific Advisory Board report on cruise missile propulsion.

- Excentric engine (USAF/APL; A)
  An independent study compared the Teledyne Excentric concept with a more-conventional two-spool engine. The advantages of the new engine were thought to be questionable. (However, a test of the engine in Lewis facilities was planned anyway).

- Tank engine (Army/TARADCOM; A)
  Consultation and advice was provided for Army studies of a new gas-turbine tank engine. We simulated an example engine on the computer for them and assisted them in establishing their own capability for thermodynamic analysis.

- Air-mobile M-X launcher (USAF/ASD; B)
  Studies compared the capabilities of alternative propulsion systems to power long-endurance aircraft.

Richard J. Weber

cc:
2010/R. Weber
2010/MAO Files

2010/RJWeber:nir:11/17/81

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Mr. **Pease**. The total number of tests conducted for the military—and I emphasize, for the military—in the Lewis facilities, from mid-1957 to 1981, number over 100, including a series of tests in Lewis' special icing research tunnel, and more are planned through 1983. The period of 1940 through 1981, that is the life of the Center, approximately 50 military engines and their major components have been tested to determine basic characteristics of the engines that are important to improving engine design or obtaining generic information useful as a basis for a new generation of engines. All the time, the Center concentrated on development techniques to understand engine behavior under all types of flight conditions.

I would like to remind the subcommittee that the nature of the NASA work is quite different from that of the Air Force, the Navy, the Army, or their contractors; since the latter, because of cost and schedule and or lack of broad expertise, are chiefly concerned about very specific aspects of engine performance. I think it is important that the subcommittee understand that the country derives great benefits from research carried out in the altitude chambers and wind tunnels at Lewis which are not obtainable from facilities such as a major air propulsion facility presently being constructed at Tullahoma, Tenn. There has been a definite complementary aspect to having civilian facilities available to provide independent and generic data for the military.

I call the attention of the subcommittee to another aspect of this civilian-military partnership which I think is worth noting. NASA has unique space facilities, particularly the propulsion and space power facilities, in which I have tried to interest the military. I spent much of my time in the last two Congresses trying to convince the Air Force to use the free world's largest vacuum chamber, which is at the Plumb Works Station located in my district.

Despite a clear advantage to an Air Force satellite testing program to taking over the space power facility, which has, by the way, a replacement cost of $100 million, the Air Force chose to have someone create another empire for themselves by deciding to duplicate such a facility near Vandenberg Air Force Base. The Air Force also chose to carry out extensive modifications to facilities at Tullahoma, simply to do an interim program which could better be done at the space power facility connected with Lewis.

This experience, Mr. Chairman, simply reinforced my concern about maintaining separate civilian facilities for space and aviation. I think we have a much better chance of getting our money's worth on the civilian side, where we can demand real accountability. No one in this room, in conclusion, expects that civilian aviation will benefit in any reasonable manner if that community is forced to piggyback on military testing at Tullahoma or anywhere else versus having Lewis Research Center facilities and expertise available to develop the base for tomorrow's propulsion technology. Neither do we expect the Air Force to develop Lewis' technology base capability overnight, since that was built on 40 years of experience.

Mr. Chairman, I would like to add just two brief postscripts. One of them is that just yesterday members of our delegation visited Cleveland and had a hearing on problems of the auto industry. We went to a Ford Motor Co. engine manufacturing plant within a mile or two of Lewis Research Center. In that connection, John McCarthy, the head of the Lewis Research Center, said recently that closing down Lewis or cutting back on research and development and transportation had severely damaged the auto industry, and that in 1983, half of the engines sold in the United States will be made outside of the United States.

We went through that engine manufacturing plant and saw roughly half of the vast factory containing an engine line which has not been operating for the last 2½ years. We saw lines that were operating, that are going one week, closed down the next week, leading to extremely high—12 percent unemployment rate in our area.

It doesn't seem, to me, to make sense to cut down on Lewis' research capability and transportation and engine design in order to save money. We are scratching our heads, trying to figure out in this country what the secret is of the Japanese and the Germans in technology, and automobiles, and a lot of other areas. And one of the things we hear consistently is that, compared with the adversary relationship between industry and Government in the United States, there is a cooperative relationship in many other countries which is working to our detriment in terms of competition in fields of high technology.

NASA is a sterling example of one place where the U.S. Government and private industry work cooperatively, not at swords points, that has produced great benefits in the past and can in the future. And I think it would be tragic if we cut that off.

Last, Mr. Chairman, I again would like to just thank you for the opportunity to testify and to request permission to submit additional material for the record.

Mr. GLICKMAN. Without objection, so ordered.

I thank you all for your excellent testimony.

As I understand, the letter to President Reagan, which will be included in the record, was signed by every member of the delegation, it was bipartisan.

Ms. OAKAR. Bipartisan, including Del Latta of the Budget Committee.

Mr. GLICKMAN. Mr. Dunn.

Mr. DUNN. I, too, have been up to the Lewis Research Center, and am deeply impressed with Mr. McCarthy and the operation he runs there. I think Congressman Mottl touched on the automobile research that they do there, and even though this is technically a hearing on aeronautic research, I would like to follow up his comments.

The chairman and I fought very hard to include $33 million for the engine research they are doing there. Unfortunately—and Congressman Pease alluded to it—we don't have the same relationship existing between the automobile industry and NASA that we have existing between the aircraft industry and NASA. While you can see graphic examples of what has happened as a result of that relationship with the aircraft industry, I would disagree that such results have been reached with the automobile. The Big Three are virtually ignoring what is going on in this research center. You may not like that, and I may not like that, but the chairman and I spent 2 days in Detroit, and that is what we found.

General Motors tells us they spent close to $2 billion on R. & D., Ford Motor close to $1.6 billion; and they came close to telling us where we could put our $33 million at the Lewis Research Center.

This is not the type of cooperation which produces results.

Thank you.

Mr. GLICKMAN. Mr. Flippo.

Mr. FLIPPO. Thank you, Mr. Chairman.

I want to commend each one of the members for what I thought was some very thorough and thought-provoking statements. And I am pleased to see such outstanding representatives from the entire Ohio delegation who did an outstanding job.

There is one area that I know you want to be on the record that I will mention. You have made outstanding cases for Lewis, which is really a unique facility. And the Nation can ill afford to lose that capability. And I just wondered if each of you would like to go on record as being in favor of all NASA Centers in supporting those areas as well. I know your interest is far more than just the Ohio area.

Ms. OAKAR. Let me just say, Congressman—I mentioned in passing—it is not part of my statement, but parenthetically I did say at the outset—that we stand ready as a delegation to assist in no cuts for NASA, because we realize the valuable contributions of those centers across the country and how they complement each other in terms of the total picture for making our country No. 1 in technology. So, I certainly want to state for the record my support for all the Centers, including the excellent Center in Alabama that you——

Mr. FLIPPO. It is an excellent Center in Alabama, but so is Goddard, and Johnson, and Kennedy, and every single facility that is being operated.

Ms. OAKAR. Absolutely.

Mr. PEASE. Mr. Chairman, I couldn't agree more with the gentleman from Alabama. And I am grateful to him for giving us the opportunity to emphasize that point. It would be a tragedy to state only my view or for individual Members of Congress to get into the game of fighting over a distinctly smaller piece of the pie of NASA research. We need to be mutually supportive of all the Centers and not consider that we won a victory if we get money at the expense of some other important component of NASA research capability.

Mr. GLICKMAN. Thank you, Mr. Flippo.

I want to thank our witnesses again for the support they've given to this NASA aeronautics space program.

Thank you for coming. Thank you very much.

Ms. OAKAR. Mr. Chairman, if I might add, my subcommittee, which relates to Federal employees, is going to have hearings on the future—on overall impact of how this would hurt Federal employees. And I certainly want to extend an invitation to this subcommittee to appear as witnesses relative to that aspect of the total picture.

Mr. GLICKMAN. We appreciate that.

We next have what I call an interesting and, I think, historic group of witnesses. We have representatives of the leading aeronautics-related companies in America here. And I would like all of these gentlemen to come up here. We have Mr. J. E. Steiner, vice president of of the Boeing Co.; Mr. Rodger Schaufele, vice president of engineering, Douglas Aircraft; Thomas Donohue with General Electric; Mr. F.A. Cleveland, vice president of engineering, Lockheed; and Mr. Maurice Shank of Pratt & Whitney. And I say it is historic because I don't think we have ever had a hearing before this committee in which we have had the leaders of American aeronautics here at one time.

So, we welcome you here. All of your statements will appear in the record in their entirety, so you may feel free to summarize as you wish.

STATEMENT OF J. E. STEINER, VICE PRESIDENT, CORPORATE PRODUCT DEVELOPMENT, THE BOEING CO.

Mr. STEINER. Mr. Chairman, members of the subcommittee, ladies and gentlemen, I am John E. Steiner, vice president of corporate product development for the Boeing Co. And seated with me are: Mr. F. A. Cleveland, vice president, engineering, for Lockheed Corp.; Mr. Rodger D. Schaufele, vice president, engineering, for Douglas Aircraft Co. of the McDonnell Douglas Corp.; Dr. Maurice E. Shank, director engineering-technical for commercial products division, Pratt & Whitney Aircraft Group, United Technologies Corp.; and Mr. Thomas F. Donohue, general manager of advance engineering and technology programs department of the aircraft engine business group, General Electric Co.

As you mentioned, statements prepared by all five of the industry representatives have been submitted for the record. I would like to start with a brief summary, and it will be followed by summaries of the others in the order in which I just read them off, with your permission.

Starting with my summary, I have been involved in the U.S. military and civil aeronautics for over 40 years. More specifically, I have participated in technology development and application over this entire time.

My purpose in being here today is to offer some insight on the significance of the first A in NASA. NASA does not design aircraft nor does NASA produce aircraft. This is not their job. NASA's job is in the aeronautical research and technology. DOD, industry, and the universities have major aeronautical research roles as well. And to understand the relationships, one must first understand the processes in aeronautical advancement.

Aeronautical research in this Nation and abroad progresses through three distinct phases.

The first phase, basic research, is the fairly continous effort that produces the fundamental knowledge from which we recognize advancement potentials. It is the core research output from NASA.

The second phase involves the expansion of basic discipline-oriented knowledge into bodies of technology that are sufficiently credible to have potentials to move on to the third phase, which is their application, development—generally by industry—and production commitments for military and commercial aircraft.

The second phase is the longest and most complex and difficult to accomplish. It represents the gathering of a body of technology that has credibility. It can require years, if not decades.

This phase is where NASA's unique role as an independent research agency has been pivotal to the success of the Nation's military and civil efforts. At this stage of research, there is little difference between the two—that is, civil and military. Each has benefited, in turn, from the other's individual priority; and NASA is the synergistic linkage.

Two decades ago, military priorities surfaced first, and much of the resultant technology flowed from military side to the civil. Today this has changed, and a substantial amount is flowing in the other direction.

There are several reasons. We are entering a new era of priorities that has elevated the need for technological efficiency on the military side as well as on the civil side. Increased fuel efficiency is a major focus, but this also has to address many other life cycle cost parameters.

Operational affordability has become as significant as operational performance, if not more so. And the commercial technology requirements, such as lightweight structures and fuel-efficient engines, have become more significant to military applications.

Second, aviation's potentials for efficiency improvement are far from approaching their limits. This is not a mature industry.

The technologies producing a 30- to 50-percent improvement in commercial transport fuel efficiencies can also yield a like reduction in weight or size for many military missions. Such improvements will be derived from vehicle integrations of advancements in structures, propulsion, aerodynamics, and flight controls. The efficiency benefits are huge, and so is the phase 2 research task.

This does not imply a lack of involvement by industry in phase 1 and phase 2 research. It does indicate that NASA represents a unique national resource of facilities and expertise that is not and should not be duplicated by either the military or civil aviation components of this country. Such duplication would lead to prohibitive costs, both civil and militarily.

Industry has sizable research capabilities of its own. They complement those of NASA with a phase 3 capability—as I mentioned before. They are alined to industry's primary development responsibilities for technology application and product design.

Fifteen years of reduced military spending have precluded the DOD's ability to fund much development beyond that contained in the specific aircraft system acquisitions. DOD's in-house capability for phase 1 has virtually disappeared, and its phase 2 capability is greatly reduced. With this, DOD has become increasingly dependent upon NASA facilities and expertise for both core knowledge and specific problem solutions.

I have interrogated the military personnel—some of whom have written letters, and they agree with these statements.

Some of the budgeteers are now advising that the first A should be dropped altogether. I'll address the consequences of this advice in a moment. But for now, I'll point out that complacency of this nature is deadly. We've progressively reduced the independent and stimulative mechanism that bonded the Nation's aviation strength by theoretical and demonstrated challenges.

Such stimulants continuously extend the technological base for the Nation's military options, and they prod industry and the academic institutions alike into doing a better job.

The danger is that such complacency is built on success, when much of that success is due to a national partnership effort of well over two decades ago. The result is a $30 billion a year industry, with half of that value realized in export sales this last year alone.

Ironically, the European aerospace industry, the Japanese industry, and their governments have patterned surging aeronautical programs after the highly successful NACA-NASA formula. They have done so with the full recognition that the greatest benefit and the greatest cost effectiveness are realized when the basic research and technology readiness for civil and military applications are not compartmentalized.

The implications are sobering. The pivotal role that NASA has represented in American aeronautics is no longer unique. Similar organizations are flourishing in most of the industrialized nations, and in some areas with research expertise and facilities matching and surpassing any to be found in the United States.

The results are sobering as well. On the commercial side, American industry has lost about 25 percent of its commercial transport market to the European aircraft industry—and I'll point out that 60 percent of the open world market of $126 billion in the next 11 years is in offshore sales.

Such erosions, once started, tend to be very longterm, if not permanent. The commuter aircraft industry is another example. And while commuter service is a growth sector in U.S. transportation, most of the new equipment that it will buy is being developed by foreign manufacturers.

In 1980, the United States imported $3.5 billion worth of aircraft and parts. This, too, should be sobering, in view of the rate of increase—some 700 percent in 4 years.

Mr. Chairman, the dismembering of our U.S. aeronautical research and technology establishment in favor of foreign interests is what this is all about. Events such as that which occurred in the last 24 hours—cancellation of L1011 commercial transport production—are expected consequences.

Comparisons between United States and foreign aeronautical research are chilling. The National Academy of Sciences convened a review on this subject last year and noted the following with respect to new efficiency potentials in aeronautics:

> One decade from now, world leadership in aeronautics will be achieved, in all probability, by the nation or nations that seize the initiative and move such technologies through the refinement and validation processes essential for successful production and operation of more efficient aircraft.
>
> Considering the erosion of momentum in the U.S. aeronautical technology, the opportunities may favor a foreign competitor if this country fails to maintain and improve its technological capabilities in aeronautics.

It's difficult to say, but I believe that the Academy's statement implies a clear warning that this Nation's research leadership has already reached a point of transition. The trends that we've noted would indicate that this is true.

There are nearly 700,000 direct jobs involved. The sustained trend of decreases in NASA aeronautics is the worst type of false economy. It invites foreign initiative to overtake our domestic and foreign markets, and it will assure a loss of credibility to the Nation's security.

Technology readiness is a long-term effort. It demands a continuity of non-product-oriented research that extends well beyond the capability of industry. This is something that foreign nations have learned from us, and it is the formula for success that we, as a nation, have neglected to observe.

I would like to summarize with the following points:

One, aeronautical research is conducted in an orderly process of three distinct phases. The first two phases may contain product potentials, but they do not have specific product orientations—military or commercial.

Two, historically, the successful U.S. accomplishment of the first two phases has involved a research partnership and a continuity of effort between NASA, DOD, industry, and the academic institutions. NASA's aeronautics role is pivotal in maintaining the continuity of effort and experience to the benefit of all.

Three, the U.S. partnership formula for aeronautical research and development has been patterned by other nations with remarkable success in a relatively short span of years.

Four, aviation exploitations will extend well beyond our times. Its potentials are a vital resource of power for the countries that are working on their development. This Nation cannot preserve aeronautical strength by barriers to trade or technical interchange. It will require that we work harder and smarter, that we reassemble our partnership, and that we reassess the present attitudes on responsibilities—public and private.

I am here to support the continue funding of NASA's aeronautics program.

Thank you.

[The complete prepared statement of Mr. Steiner follows:]

Statement by
John E. Steiner
Vice President, Corporate Product Development
The Boeing Company

Before

Committee on Science and Technology
Subcommittee on Transportation, Aviation and Materials
U.S. House of Representatives
December 8, 1981

Introduction

Mr. Chairman, Members of the Subcommittee, Ladies and Gentlemen:

My name is John Edward Steiner. I am Vice President, Corporate Product Development for The Boeing Company. I have been involved in United States military and civil aeronautics for over 40 years; more specifically, I've participated in its technology development and application over this entire time.

My purpose in being here today is to offer some insights on the significance of that first "A" in NASA. NASA does not design aircraft nor does NASA produce aircraft. That is not their job. NASA's job is in aeronautical research and development. DOD, industry and the universities have major aeronautical research roles as well, and to understand the relationships, one must first understand the processes in aeronautical advancement.

Phases in Aeronautical Development

Aeronautical research, in this nation and abroad, progresses through three distinct phases. The first phase, basic research, is the fairly continuous effort that produces the fundamental knowledge from which we recognize advancement potentials. Such knowledge is derived from hundreds of government, academic and industrial research facilities in many countries. It is the core research output from NASA.

The second phase involves the expansion of basic discipline-oriented knowledge into bodies of technology that are sufficiently credible to move potentials on to a third phase . . . their application development and production commitments for military and commercial aircraft.

The second phase is the longest, and most complex and difficult to accomplish. It can require years, if not decades to develop the needed bodies of knowledge to a state of readiness. This phase is where NASA's unique role as an independent research agency has been pivotal to the success of the nation's military and civil efforts. At this state of research, there is little difference between the two. If any, it has been a difference in priority, with the military emphasis on operational performance and a civil aviation priority on safety and improved economy. Each has benefitted in turn from the other's priority and NASA's involvement. By example, it took some 10 to 15 years of phase two research to successfully optimize the swept wing and axial flow jet engine combination. This amounted to a national aviation effort that yielded air superiority for our nation's defense and also an undisputed edge in civil transport aircraft. NASA research was the synergistic linkage between the two achievements.

A New Era of Aeronautical Research

Two decades ago, as noted in this example, military priorities surfaced first, and much of the resultant technology flowed from the military side to the civil. Today this has changed, with a substantial amount of the flow from the other direction.

There are several reasons for this. Firstly, we are entering a new era of priorities that has elevated the need for technological efficiency on the military side, as well as that of the civil. Increased fuel efficiency is a major focus for this priority, but it also addresses many other life cycle cost parameters. Operational affordability has become as significant as operational performance, if not more so, and the commercial technology refinements such as light weight structures and fuel efficient engines have become much more significant to military aircraft applications.

Secondly, aviation's potentials for efficiency improvement are far from approaching their limits. The commercial industry has produced a 30% improvement in fuel efficiency over each of the past three decades and this trend will continue or possibly accelerate over the next two. The advancement potentials now visible would indicate the latter, and much of it has direct implications to military affordability and performance enhancement. For example, the technologies producing a 30 to 50 percent improvement in commercial transport fuel efficiencies can also yield a like reduction in weight or size for many military missions. Such improvements will be derived from vehicle integrations of advancements in structures, propulsion, aerodynamics and flight controls. The efficiency benefits are huge, and so is the phase two research task.

The structures part, as an illustration, would involve composite applications to primary structural elements such as the wing torque box. Before this is done we must have a better understanding of the composite filaments and resins themselves, and a better knowledge of the basic properties of their bond and its change with time and environment. We need to know more about the structural system's permeability to moisture and fuel; its integrity under natural elements such as lightning; and for military applications, its combat survivability. There are different and unfamiliar aeroelastic properties involved, and we must understand their implications to design.

The U.S. Aeronautical Research Mechanism

We've noted that NASA's basic research (phase one) is a core contribution to our national knowledge and that NASA's phase two research involvements have been pivotal in America's aeronautical successes. This does not imply a lack of involvement by industry in phase one and phase two research. It does indicate that NASA represents a unique national resource of facilities and expertise that is not and should not be duplicated by either the military or civil aviation components of this country. Such duplication would lead to prohibitive costs.

Industry has sizeable research capabilities of its own. They complement those of NASA's with a phase three capability aligned to industry's primary development responsibilities for technology application and product design. The cooperative efforts between NASA, DOD, and industry have worked and continue to work. They have been a bright spot in the otherwise adversarial situation that exists in so much of the relationship between public and private sectors. More importantly, they have worked in a cost effective manner that has avoided costly duplication of facilities and effort, and capitalized on advancement spin-outs achieved by both the military and civil sides.

Status of Present U.S. Capability

However, the research foundation that elevated this nation's capabilities has changed with the steady erosion of government support the past decade and a half. Fifteen years of reduced military spending has precluded the DOD's ability to fund much development beyond that contained in the specific aircraft system acquisitions. DOD's in-house capability for phase one has virtually disappeared and its phase two capability is greatly reduced. With this, DOD has become increasingly dependent upon NASA facilities and expertise for both core knowledge and specific problem solutions.

NACA was succeeded by NASA in 1958, and since that time NASA's first "A" has been lower case, and also of diminishing size as its aeronautical program has been reduced. Its independent research character has changed with a drift toward the contracted research mode more aligned to the agency's space management role. Some of the budgeteers are now advising that the first "A" should be dropped altogether. I'll address the consequences of this advice in a moment, but for now, I'll point out that complacency of this nature is deadly. We've progressively reduced the independent and stimulative mechanism that bonded the nation's aviation strength by theoretical and demonstrated challenges. NASA's many high speed and high altitude subsonic and supersonic advancements are examples of this as are the more recent contributions to flight efficiency. Developments such as the area rule and supercritical airfoils, while not applied directly in many cases, were stimulants which produced a better and more competitive U.S. industry. Such stimulants continuously extend the technological base for the nation's military options and they prod industry and the academic institutions alike into doing a better job.

Implications of the Present Trend

The danger is that such complacency is built on success, when much of that success is due to national partnership efforts of well over two decades ago. The result is a 30 billion dollar year industry, with half of that value realized in export sales this last year alone.

Ironically, the European aerospace industry, the Japanese industry and their governments have patterned surging aeronautical programs after the highly successful NACA-NASA formula. They have done so with the full recognition that the greatest benefit and the greatest cost effectiveness are realized when the basic research and technology readiness for civil and military applications are not compartmentalized.

The implications are sobering. The pivotal role that NASA has represented in American aeronautics is no longer unique. Similar organizations are flourishing in most of the industrialized nations, and in some areas, with research expertise and facilities matching or surpassing any to be found in the U.S. Where the U.S. economy of scale is a problem, this too has been overcome through various forms of international partnership in research, development and production, both military and commercial.

The results are sobering as well. On the commercial side, the American industry has lost about 25 percent of its commercial transport market to the European aircraft industry — and I'll point out that 60 percent of the world open market of $126 billion is in off-shore sales. Such erosions, once started, tend to be very long-term if not permanent. The commuter aircraft industry is another example, and while commuter service is a growth sector in U.S. transportation, most of the new equipment that it will buy is being developed by foreign manufacturers. In 1980, the United States imported $3.5 billion worth of aircraft and parts; not a staggering amount, considering the $15 billion in exports. However, this too should be sobering in view of the rate of increase . . . some 700 percent within four years.

Such comparisons between U.S. and foreign aeronautical research growth are chilling. The National Academy of Sciences convened a review of this subject last year and noted the following with respect to new efficiency potentials of aeronautics:

> "One decade from now, world leadership in aeronautics will be achieved, in all probability, by the nation or nations that seize the initiative and move such technologies through the refinement and validation processes essential for successful production and operation of more efficient aircraft.
>
> "Considering the erosion of momentum in U.S. aeronautical technology, the opportunities may favor a foreign competitor if this country fails to maintain and improve its technological capabilities in aeronautics."

This is difficult to say, but I believe that the Academy's statement implies a clear warning that this nation's research leadership has already reached a point of transition. The trends that we've noted would indicate that this is true.

Summary

In time, the comparatively slowed state of American technological momentum will have major economic consequences. There are nearly one million direct jobs involved, and each billion dollar loss in our commercial export sales, for example, will translate to roughly a three billion dollar drain from the nation's economy. On the military side the consequences are equally serious since delayed readiness translates into significantly increased costs.

The sustained trend of decreases in NASA aeronautics is the worst type of false economy. It invites foreign initiative to overtake our domestic and foreign markets, and it will assure a loss of credibility to the nation's security. Technology readiness is a long-term effort. It demands a continuity of non-product oriented research that extends well beyond the capability of industry. This is something that foreign nations have learned from us, and it is the formula for success that we, as a nation, have neglected to observe.

I would like to summarize with the following points.

1. Aeronautical research is conducted in an orderly process of three distinct phases. The first two phases may contain product potentials but they do not have specific product orientations — military or commercial.

2. Historically, the successful U.S. accomplishment of the first two phases has involved a research partnership and a continuity of effort between NASA, DOD, industry and the academic institutions. NASA's aeronautics role is pivotal in maintaining the continuity of effort and expertise to the benefit of all.

3. The U.S. partnership formula for aeronautical resesearch and development has been patterned by other nations with remarkable success in a relatively short span of years.

4. The world influence derived from aviation exploitations will extend well beyond our times. Its potentials are a vital resource of power for the countries that are working on their development. This nation connot preserve aeronautical strength by barriers to trade or technical interchange. It will require that we work harder and smarter; that we reassemble our partnership; and that we reassess the present attitudes on responsibilities . . . public and private.

I am here to support the continued funding of NASA's aeronautical program.

Thank you.

Mr. GLICKMAN. Thank you for that excellent statement. Mr. Steiner.

Mr. Cleveland.

STATEMENT OF F. A. CLEVELAND, VICE PRESIDENT, ENGINEERING, LOCKHEED CORP.

Mr. CLEVELAND. Mr. Chairman and members, I, of course, endorse completely everything that Mr. Steiner has presented. I intend to speak to some of the specifics to which he alluded in order to indicate what some of the potentials for the future may be if we, in fact, do proceed in the areas where we feel we should.

This will be about a 5-minute summary of my written testimony.

The plea is, of course, a plea for knowledge instead of ignorance. We seem to have somehow achieved the trappings of being a mature industry at a time when we are really still in our aeronautical infancy.

People have the notion that there is so little left to do that we don't have to do that kind of research. I would like to cite some examples. These are some of the things which Congressman Harkin referred to as "possible barriers". They are not barriers, they are opportunities which will give us the ability to do things that we have never been able to do before.

In the first place, believe it or not, there are some serious uncertainties and unknowns in the very aerodynamics we live with. Sizable reductions are still possible in the total drag of air vehicles if we could just understand turbulent aeodynamics better.

The use of microelectronics to solve nonelectronic problems has tremendous promise for us. We can apply electronics to develop load alleviation systems, using active control systems; we will find ways of solving problems in hydraulics, in propulsion, and in other areas where electronics are not normally thought of as being applicable. We've barely scratched the surface here and have a great deal of opportunity to do more.

In the propulsion area the internal aerodynamics of engines are the sort of thing that is worked on very productively by the people at Lewis. Alternate fuels, the kinds which will be safer in combat, those which will be safer in crashes, and those which may bring very high energy capabilities to us still have much room for growth. And some of them can be synergistic with such things as laminar flow control.

High-temperature materials inside of engines still leave, according to some of the experts I have talked to, 1,000 degrees growth in turbine inlet temperature, which will have remarkable consequences ultimately on the size and efficiency of engines which can be developed.

Safety itself is an important area that NASA makes substantial contributions in—of course, in support of both the industry and the FAA's charter; many of the things that they, NASA, contribute are very useful in that regard.

If we had all of these things, at least to some degree, what could we do? They are absolutely essential to the military community—where competition, in the ultimate case, is only for first place;

there is no second place—or in the commercial community, where the capability could be evaluated by an economic assessment.

We could have airplanes, as has been indicated by others, that would save up to 50 percent in fuel for flying a given payload for a given range. Or we could have smaller airplanes that could do the same job.

We could have long-endurance airplanes for many of the military missions in particular, such as warning, communications, antisubmarine warfare, carrying over-the-horizon radar and so on, which could remain aloft for 24 to perhaps 120 hours.

In an extreme case, we might have an airplane that we call a semisatellite which could orbit at very high altitudes almost indefinitely, using solar cells for power and accomplishing some of the kinds of missions I indicated.

Strategic missions of very great range could be flown between mach 3 and mach 6. Adequate improvements in the V/STOL area, which were also alluded to by at least one of your congressional panel members, could result in aircraft capable of operating from very small naval vessels in support of Navy battle groups.

This, of course, brings us around to the point: Why doesn't industry step up to and undertake this burden?

There are four major uncertainties which lie between our present level of understanding and the exploitation and solution of these problems:

First is the technical possibility of doing the job at all.

Second is the economic feasibility of that technical solution.

Third is the possibility that new Government regulations may not permit us, either at all, or economically, to use the solution found.

Fourth, and most important, is the fact that by the time we get a solution, the particular market we were aiming at may not even be there. An example might be the possibility that the traveling public might not choose to fly on propeller-driven airplanes even if we had the very great fuel and economic improvements that NASA has been developing in that particular area.

At the very least, profoundly constrained as we must be by the those four uncertainties, the technological pace of the U.S. aeronautical industry is in serious jeopardy. And it's paradoxical that at this time in history, when we finally recognize the rationale and the need for multiplying NASA's aeronautics budget by, say, a factor of 2, the administration is, in fact, considering using that 2 in its demoninator. We hope that a higher order of wisdom will prevail.

Thank you.

[The complete prepared statement of Mr. Cleveland follows:]

Statement by
F. A. Cleveland
Vice President, Engineering
Lockheed Corporation

Before

Committee on Science and Technology
Subcommittee on Transportation, Aviation and Materials
U. S. House of Representatives
December 8, 1981

My name is F. A. Cleveland. I am Corporate Vice President, Engineering for the Lockheed Corporation. I have been closely involved in aeronautical research, technology, and development programs steadily since 1944.

It is trite, but necessary for the sake of completeness, for me to state complete endorsement of the comments made by Mr. Steiner. His perspective, his facts, and his rationale are all right on target. It is my intent to speak to some specifics which complement and support his testimony.

My primary thrust this morning is to make a plea against ignorance. Unfortunately we in the aviation industry have managed to give the impression to the world at large that we have succeeded in our technological quests to the point of diminishing returns; that is, the performance capabilities of our military products, and the economic capabilities of our commercial ones, have led many to believe that few further gains are possible, or at least necessary. We have thus acquired the external trappings of a technologically mature industry.

Well, I'm not dead sure what the phrase "technologically mature" means but I am sure that we are still in our teens, if not our infancy, technically. Let me illustrate with examples which all fall in the domain of NASA aeronautical R&D.

If there is one thing you would reasonably expect an aeronautical industry to understand absolutely and be able to calculate and predict very accurately, it is aerodynamics —— the behavior of the air flowing around all of the components of an aeronautical vehicle. Nothing could be farther from the truth. We do have semi-empirical prediction and computational methods that serve; we have an enormous data base from experience in wind tunnels and in flight; and we do a great deal of wind tunnel work as a new design is developed to be sure we're not making a mistake, even before flight testing to absolutely prove its adequacy. But despite the efforts of some of the most celebrated minds of our time, turbulence aerodynamics is still incompletely understood.

Closely associated with the situation in turbulence aerodynamics is a special component of it —— noise. Though the physics of the problem are reasonably understood, ignoring the turbulence element, propagation and suppression of acoustic treatment remain susceptible to further understanding and the potential improvement accruing therefrom.

The metallurgy of our common materials of construction is still in many ways a black art. We have an enormous data base which is founded on decades of experience and trial and error. It permits us to have confidence in the materials we use today. But the arrival of composites on the scene has created an entirely new ballgame where even our present uncertain metallurgical knowledge is grossly insufficient. We also now have interfaces between materials which did not even exist in the structural imagination 20 years ago. In some cases we are actually planting whiskers or strands of elements and of compounds in metals to achieve startling improvements and potential tailoring of the material for the particular component of the vehicle to which it is being applied. There are tremendous voids in our knowledge in this entire area.

One of the most important areas in materials of construction is fracture mechanics, the study of the behavior of material under repeated stressing cycles prior to and during crack nucleation, and further during crack growth. Dealt with by statistical probability methods to date (and perhaps forever into the future), problems in this discipline are profoundly compounded by the advent of composites, which bring them new uncertainties in fatigue and fracture characteristics.

Another area where we know much less than we should is that of the man/machine interface. Our new technological capabilities in instruments, displays, and controls in the flight station make possible previously-unheard-of flexibility in the means by which the flight vehicle can convey information to its crew and the means by which the crew can impart directions back to it. Based in great part on progress in electronics, some of the eventual possibilities are mind-boggling. But a great deal of work must be done in very basic R&D to understand all of the potential means and interactions and their effects on the performance of the man and the machine in terms of both performance and safety. A gradual reduction in the need for crew members, substantially attractive where combat danger is implicit, is inevitable.

The man/machine interface introduces the general area of the use of electronics in solving non-electronic problems. There are vast challenges and opportunities, mostly unidentified to date, where this will occur. Significant drag reductions due to the introduction of artificial stability have great promise. Saving structural weight by reducing loads will under certain circumstances improve efficiency, and that concept may also be applied to the strict military case of load relief for more battle damage tolerance. Military derivatives of four-dimensional navigational concepts will improve multi-vehicle coordination in many military circumstances. Some of the difficult structural dynamics and aerodynamic problems of rotary wing vehicles will probably also succumb to the new electronics and many improvements in aircraft subsystems —— propulsion, hydraulics, electrical, and pneumatic —— will probably accrue.

Propulsion is a discipline rife with potential for further developments other than electronics. NASA has been carrying the energy efficient engine program for years with great success and they are the heartland of the development of future high speed propfans. The internal aerodynamics of turbine engines hold the same promise that the external aerodynamics of the vehicles do. Really efficient propulsion for vertical or short takeoff and landing has not yet really arrived; both direct lift systems and surface-blowing-interaction systems are far short of their hoped-for ultimate potential.

Alternate fuels as possible petroleum substitutes have much to offer that is not yet defined or characterized adequately. I can't resist mentioning that cryogenic fuels, such as liquid hydrogen, offer conceivable synergism with either laminar flow control by severe surface cooling, or with the structural cooling required to permit hypersonic flight. Some brand new engine cycles have been proposed and may ultimately make significant contributions if their R&D is continued.

High temperature materials are a special consideration in their own right. The possibility of turbine inlet temperature increases of as much as 1000°F are within sight and the effect on the entire flight vehicle design and its efficiency would be enormous. Parenthetically, the spin-off into step-function efficiency increases for stationary and other mobile power plants would also be profound.

Safety is an all pervasive word that is certainly important to the military, but is absolutely central to the commercial side of aeronautics. Despite the tremendous safety record of commercial aviation there is still much that can be done. For example, an understanding of structural crashworthiness is fairly new. Non-metallic materials of construction and trim inside fuselages can be improved further in terms of flammability, toxicity, and smoke generation. Fuels and fuel systems may be subject to further improvement, but certainly may not be improved unless work is prosecuted. The vehicle flight characteristics and handling qualities constitute an important element of flight safety, and new concepts of fail-safety and redundancy will occur as development work continues.

A final area where substantial improvements are possible is that of the analytical tools and methodologies used in the development process. I've already alluded to the problems of aerodynamics where that entire subject is called "computational fluid dynamics." It is certainly an active one, deeply in the research phase at present and for many years to come. Structural analytical methods are also in the same category, though their development is ahead of those for fluid dynamics. NASA's integrated programs for aerospace vehicle design, or IPAD, will remain in development for many years. All of these tools increase design efficiency by improving speed and accuracy of analysis and by permitting exploration of more possible approaches to an analytical or design problem, great virtues in the aeronautical community.

Assume for the moment that all of the areas I have mentioned continue to get the attention and support that we are recommending. What benefits would accrue? Basically they would be one or both of two types. The first is an improvement in the technical or performance capability of the aeronautical vehicles, essential to the military community where competition in the ultimate case is only for first place —— second is not survivable. For the commercial community the capability improvements would be translated through an economic assessment before their virtues could be exploited.

Considering only the military side here are a few of the things we could do:

1. For a given mission range and payload for military cargo aircraft, save up to 50% on the fuel consumed per mission. Alternately make the airplane smaller to carry the same cargo the same distance or increase the unrefueled range for the same size airplane, perhaps making intercontinental round trips without re-fueling until home.
2. Remain aloft for periods of say 24 to 120 hours without refueling. The military missions which would benefit from this capability reside in the areas of warning, communications, antisubmarine warfare, over-the-horizon radar operation, battle management, and battle group protection for the Navy.

In an extreme case, a vehicle which might be called a semi-satellite could orbit at very high altitude almost indefinitely, using solar cells for power or getting power from a ground-based microwave beam, and accomplishing some of these missions.

3. Strategic missions of very great range could be flown at speeds between Mach 3 and Mach 6, substantially enhancing the survivability of aircraft exposed to combat circumstances.
4. Adequate improvements in the V/STOL area could result in aircraft able to operate from very small ships, doing support missions as a part of Navy battle groups.
5. Reflecting on the Iranian rescue mission failure, a substantial advance in V/STOL could also permit creation of an assault troop carrier which could do deep penetrations for special missions involving substantial numbers of foot soldiers and equipment and extremely limited landing areas.

It would be grossly inefficient for all the companies in the aeronautics industry to be working, not on all the subjects I have mentioned, but even only on those which have some promise of being important to their particular lines of aeronautical business. The uncertainties associated with almost all of the areas of our ignorance are tremendous. They fall principally in four classes and those four classes tend to succeed each other. They may be characterized as four fundamental questions:

1. Is the goal sought in this particular area technically possible at all or will it turn out to have been a totally wasted investment because it just can't be done?
2. Will the technical solution, if one does exist, be economically feasible; will it be worth what it costs to actually incorporate it in the design of a vehicle?
3. Will government regulations by the time the solution is ready to be employed affect in some way the ability to exploit it; will it be usable at all?
4. No matter now attractive the economics, will the user market actually be there and will it accept the particular solution that has been developed? An excellent example of this dilemma is one of today's uncertainties: Would the public accept and fly on a brand new propfan at Mach 0.8 if the same speed aircraft were offered to them alternatively without propellers but with higher fares?

I am a strong believer in examples to help clarify broader and more generic cases or principles. I hope that what I have offered gives some indication of the breadth and depth of what we do not know. That entire matrix would appear to be of such magnitude that no company, or combination of companies, could reasonably be induced, or be driven by our free enterprise system, to undertake an appreciable portion of the work to be done.

At the very least, profoundly constrained as we must all be by the four kinds of deep and perplexing uncertainties I have mentioned, the technological pace of the United States aeronautical industry is in serious jeopardy, compared with either its past progress or, more frighteningly, with the progress of its potential military enemies and its certain economic adversaries. It is indeed paradoxical that, at the time in our history when we finally fully recognize the rationale and the need for multiplying NASA's aeronautics R & T budget by a factor of two, the Administration is in fact considering using that "two" in the denominator. We urge that a higher order of wisdom prevail.

Mr. **GLICKMAN**. We thank you, Mr. Cleveland, for that excellent testimony.

Mr. Schaufele.

STATEMENT OF RODGER D. SCHAUFELE, VICE PRESIDENT, ENGINEERING, DOUGLAS AIRCRAFT CO.

Mr. **SCHAUFELE**. Mr. Chairman, members of the subcommittee, I appreciate the opportunity to appear before you today to present comments on the NASA aeronautics program.

The aeronautical technical resources that the U.S. aeronautics industry drew from was, in a large part, generated by NASA and its predessor, the NACA. Private industry applied this aeronautical research and development, and generated products used throughout the world.

The United States has an extensive investment in the NASA aeronautical research facilities that are a unique national asset. As an independent agency, NASA has been able to work with industry and generate technology for the benefit of the entire industry and the Nation as a whole.

Those industrial concerns that utilized NASA-generated technology in an effective way were able to survive in the competitive market.

With the advent of the space program, the magnitude of funding for aeronautics programs in the late 1950's and early 1960's actually decreased. The staffing of the NASA aeronautical centers was cut in half, and it now has leveled out to about two-thirds of the 1950's level.

The successful civil transports of the 1960's applied a great deal of technology which resulted from NASA-sponsored R. & D. activities. The reduction in the level of the NASA aeronautics effort during the 1960's slowed the ability of industry to incorporate into new products potentially beneficial advanced technology that was still very high risk and needed further development.

Identified potential advances in propulsion, aerodynamics, flight controls, advanced structural concepts, and composite materials could have been accelerated in the late 1960's and early 1970's to insure that U.S. transports remained superior to foreign products. Applicability of other advanced concepts in supersonics, laminar flow control, and high-speed propellers could have been established.

As it stands today, the foreign-government-subsidized civil transport industry has been able to become technically competitive and capture an increasing percentage of the world commercial transport market.

I would like to identify the growing in-roads being made by foreign-government-supported competition.

In 1971, a mockup of a new European twin-engine, wide-body transport was shown at the Paris Air Show, with a declared goal to capture a significant share of the world's civil aircraft manufacturing business. The U.S. Department of Commerce, after careful analysis, published several reports and papers that predicted successful foreign progress and that the U.S. share of the world civil transport market would decrease from the then-current level of 94 percent to under 70 percent by 1985. Now, in 1981, this is rapidly happening, and the 1985 results may be even worse than the 1971 prediction.

Foreign governments sponsor not only much of the research but, more importantly, the high-risk development phases of both the aircraft and engine. In addition, the foreign governments support the sales activities in ways that are not possible in the United States.

In 1975, recognizing the threat of foreign competition and increasing energy costs, Congress stimulated NASA into working with industry to formulate a program to enhance the applications of advanced technologies in aeronautics and was able to obtain executive support for this plan.

The resulting aircraft energy efficiency program has allowed NASA to conduct technology development in several important areas, enabling industry to incorporate these advanced technologies in their future designs. The areas of technology development included composite structures, advanced aerodynamics, flight controls, and propulsion.

This committee is well aware of this program, and we want to compliment Congress and NASA on the valuable contribution these ACEE programs have provided to our industry.

There are some long-term technology developments that might allow the U.S. industry to leapfrog the foreign competition if these programs were to continue according to the original plans. These areas are large composite primary structures, advanced propfans, and laminar flow control. The NASA program should take these concepts to large-scale ground and flight tests in order to evaluate and understand the technical merit and generate user confidence that the risk in making a design application is appropriate for the private capital investment involved.

A basic question has been generated that asks, "Should NASA continue to conduct aeronautical research?" The answer, in our opinion, is an unqualified "yes." To say that the military could do it just as well is not quite valid. The military, while conducting some degree of research in aeronautics, is basically a product developer and user and has focused program activity. The broad base of independent aeronautical technology development conducted and sponsored by NASA covers the spectrum from very near-term to very long-term applications.

NASA is the sole remaining Federal agency with a charter to maintain the United States as a leader in the world's civil aeronautics field. To do this, NASA needs to re-establish an aggressive program that addresses not only the aeronautics research and technology base, but also expands its role in systems technology studies and to support development programs on high-risk technologies that are applicable to the marketplace.

In summary, the NASA aeronautical program is a fundamental part of the health of the civil aircraft manufacturing industry. Reduced support of the NASA aeronautics program would, and has, allowed foreign competition to enter the marketplace and reduce U.S. dominance in this field. Industry needs the broad-based programs of the type NASA is conducting.

A strong NASA aeronautics program, focused and directed with proper industry and Government cooperation is vitally needed by this country if we are to protect our valuable historical role as a supplier of the free world's civil aircraft fleet.

Thank you.

[The complete prepared statement of Mr. Schaufele follows:]

8 December 1981

STATEMENT
OF
ROGER D. SCHAUFELE

Vice President, Engineering
Douglas Aircraft Company
McDonnell Douglas Corporation

before the

Subcommittee on Transportation, Aviation
and Communication
Committee on Science and Technology
U.S. House of Representatives

Mr. Chairman and Members of the Subcommittee:

I appreciate the opportunity to appear before you today and reply to your request to present comments on the NASA Aeronautics Program. The United States has exhibited leadership in all phases of aeronautics up to the early 1970's. Aerospace has been the second largest employer in the U.S. and is one of the largest contributors to the balance of trade.

The aeronautical technical resources that the U.S. aeronautics industry drew from was in a large part generated by the DoD and NASA and its ~~predecessor, the~~ NACA. Private industry applied this aeronautical research and development, and generated products used throughout the world. The U.S. has an extensive investment in the NASA aeronautical research facilities that are a unique national asset. As an independent agency, NASA has been able to work with industry and generate technology for the benefit of the entire industry and the nation as a whole. Those industrial concerns that utilized NASA generated technology in an effective way were able to survive in the competitive market. With the advent of the space program, the magnitude of funding for aeronautics programs in the late 50's and early 60's actually decreased. The staffing at the NASA Aeronautical Centers was cut in half, and now has leveled out to about two-thirds of the 1950 level.

The successful civil transports of the 1960's applied a great deal of technology which resulted from NASA and DOD sponsored R&D activities. The reduction in the level of the NASA aeronautics effort during the 60's slowed the ability of industry to incorporate into new products potentially beneficial advanced technology that was still very high risk and needed further development. Identified potential advances in propulsion, aerodynamics, active controls, advanced structural concepts, and composite materials could have been accelerated in the late 60's and early 70's to ensure that U.S. transports remain superior to foreign products. Applicability of other advanced concepts in supersonics, laminar flow control and high-speed propeller could have been established. As it stands today, the foreign government subsidized civil transport industry has been able to become technically competitive and capture an increasing percentage of the world commercial transport market.

I would like to identify the growing in-roads being made by foreign government supported competition. In 1971, a mockup of a new European twin-engine wide-body transport was shown at the Paris Air Show with a declared goal to capture a significant share of the world's civil aircraft manufacturing business. The U.S. Department of Commerce, after extensive analysis, published several reports and papers that predicted successful foreign progress and the U.S. share of the world civil transport market would decrease from the then-current level of 94% to under 70% by 1985. Now, in 1982, this is rapidly happening and the 1985 results are not yet in, but may even be worse than the 1971 prediction.

Foreign governments sponsor not only much of the research, but more importantly, the high-risk development phases of both the aircraft and engine.

Foreign government support does not end with the research and development phases. The foreign governments support the sales activities in ways that we in the private sector in the U.S. cannot afford to do.

In 1975, recognizing the threat of foreign competition and increasing energy costs, Congress stimulated NASA into working with industry to formulate a program to enhance the applications of advanced technologies in aeronautics and was able to obtain Executive support for this plan. The resulting Aircraft Energy Efficiency (ACEE) Program has allowed NASA to conduct technology development in several important areas enabling industry to incorporate these advanced technologies in their future designs. The areas of technology development included composite structures, advanced aerodynamics, flight controls, and propulsion. This committee is well aware of this program and we want to complement Congress and NASA on the valuable contribution these ACEE programs have provided to our industry.

There are some long-term technology developments that might allow the U.S. industry to leap frog the foreign competition if these programs were to continue according to the original plans. These areas are Large Composite Primary Structures, Advanced Propfans, and Laminar Flow Control. The NASA program should take these concepts to large scale ground and flight tests in order to evaluate and understand the technical merit and generate industry and user confidence that the risk in making a design application can attract private capital investment. The advanced supersonic technology program should also be in this category.

The role of the military in aeronautical research, specifically as applied to commercial transports, has changed over the years. In the years during and after World War II, research and development by both NASA and DoD provided industry with the knowledge and capability to generate its products used worldwide. In today's environment the military generates very little technology applicable to commercial transports, with most of their development going to extremely high performance combat aircraft, space or missiles. In fact, the military aircraft are utilizing the NASA sponsored systems technology developments in propulsion, aerodynamics, controls, structures, and materials. The McDonnell Douglas C-17A Air Force Cargo transport contains many spin-offs from NASA research and development such as the advanced supercritical wing, winglets, composite materials and active control systems. For future transports, the Air Force and Navy are not actively conducting any research on the Advanced Turboprop and Laminar Flow Control Concepts and their activities on large composite primary structures are not directly applicable to civil transports.

A basic question has been generated that asks, "Should NASA continue to conduct aeronautical research?" To say that the military could do it just as well is quite improper. The military as we know it in aeronautics is a product developer and user and has focused program activity. The broad base of independent aeronautical technology development conducted and sponsored by NASA covers a broad spectrum from near to very long term applications. Industry, under its current financial structure, cannot afford to do all the things that NASA is doing.

NASA is the sole remaining federal agency left in the U.S. Government with a charter to maintain the U.S. as a leader in the world's civil aeronautics field.

To do this, NASA needs to re-establish an aggressive program that addresses not only aeronautics Research and Technology base but also expands its role in Systems Technology Studies, and support to joint industry development programs on high-risk technologies applicable to the civil transport marketplace.

In summary, the NASA Aeronautical program is a fundamental part of the health of the civil aircraft manufacturing industry. Reduced support of the NASA Aeronautics programs would, and has, allowed foreign competition to enter the marketplace and reduce the U.S. dominance in the field. Industry is not in a position to conduct the broad based programs of the type NASA is conducting, especially in the systems technology development phase.

A NASA Aeronautics program, focused and directed with proper Industry and Government cooperation is vitally needed by this country if we are to protect our valuable historical role as the supplier of the free world's civil aircraft fleet.

Thank you.

Mr. GLICKMAN. Thank you very much, Mr. Schaufele.

Mr. Shank.

STATEMENT OF MAURICE E. SHANK, DIRECTOR, ENGINEERING-TECHNICAL COMMERCIAL PRODUCTS DIVISION, UNITED TECHNOLOGIES CORP., PRATT & WHITNEY AIRCRAFT GROUP

Mr. SHANK. Thank you very much, Mr. Chairman.

We at Pratt & Whitney Aircraft want to thank the committee for asking us to comment on the importance of the NASA aeronautics program. As has been pointed out, aeronautics is second only to agriculture in terms of U.S. exports and ranks No. 1 in net exports.

Despite large commitments by the U.S. aircraft industry in research and development, there is growing evidence that the once dominant leadership of the United States is now in question. Erosion of this Nation's commercial aircraft market has been effected by foreign government-supported industry.

We believe the United States must maintain its position of world leadership in aeronautics. This will require both enormous private resources to finance high technology ventures and a continuing ability to stave off government-supported foreign competition through U.S. leadership in technological achievement. Our Government and industry must work together, more than ever, to maintain first place.

NASA has traditionally provided a stimulus to the aeronautical industry by supporting proof-of-concept work. This conceptual technology has shown the way for industry to channel its development resources. Past testimony before this and other committees has provided the evidence of NASA contributions to technology in aeronautics which benefited both commercial and military aviation. I would like to recall one proof-of-concept example stimulated by NASA Lewis Research Center which led to the technology developed by our industry in the 1950's enabling compressors to accept a higher axial velocity of the air passing through. That work on the transonic flow compressor became the basis of today's high-efficiency compressor designs. It made possible the modern efficient, high-bypass ratio turbofan, leading to U.S. supremacy in the engine field. Today, NASA's energy-efficient engine program is the proof-of-concept vehicle for new technologies, promising further improved fuel consumption in future engines. And NASA's support of the prop-fan concept, with its potentially dramatic fuel savings, could usher in the next significant innovation in aviation history.

American industry has not lost its willingness to accept the responsibilities associated with the development of high technology, advanced new concepts, and products for the market. For instance, this month we are now testing our newest, most advanced engine, the PW2037. Its total development cost will exceed $1 billion. Because of increasing competition, industry resources are currently focused on nearer term product improvements. NASA's advanced thinking, planning, and support of proof-of-concept testing is essential at this time, when industry resources are focused on nearer-term supremacy.

For these reasons, we believe that the level of NASA funding devoted to aeronautics should be continued. As we understood the administration's fiscal year 1982 budget last spring, the aeronautics budget represented only 8.5 percent of the total NASA budget. We believe that the aeronautics portion is inappropriately low when weighed against the benefits to the U.S. economy.

We firmly support the administration's general economic recovery plans, including reduction of Government spending. Within the guidelines of these plans, however, it is appropriate to adjust priorities to best serve the Nation's interest. Within these guidelines, therefore, we strongly urge preservation of the NASA aeronautics budget, including programs for propulsion research and technology.

Thank you, Mr. Chairman.

[The complete prepared statement of Mr. Shank follows:]

NASA AERONAUTICS AUTHORIZATION

STATEMENT OF
UNITED TECHNOLOGIES CORPORATION
PRATT & WHITNEY AIRCRAFT GROUP

December 8, 1981

by

Dr. M. E. Shank
Director, Engineering — Technical
Commercial Products Division

Prepared for
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON TRANSPORTATION, AVIATION, AND MATERIALS
HONORABLE DAN GLICKMAN, CHAIRMAN

UNITED
TECHNOLOGIES

We at Pratt & Whitney Aircraft thank you for asking us to comment on the importance of the NASA Aeronautics program. The NASA Aeronautics program, through its research and technology has benefited civil and military aviation. We urge careful examination of the potential benefits of the NASA Aeronautics program to support economic recovery and long-term economic strength, particularly relative to aeronautical products as an export item.

Aeronautics is second only to agriculture in terms of U.S. exports and ranks number one in net exports. Despite large commitments by the U.S. aircraft industry in R&D, there is growing evidence that the once dominant leadership of the United States is now in question. Erosion of this nation's commercial aircraft market has been effected by foreign government-supported industry.

We believe the U.S. must maintain its position of world leadership in aeronautics. This will require (1) enormous private resources to finance high technology ventures and (2) a continuing ability to stave off government-supported foreign competition through U.S. leadership in technological achievement. Our government and industry must work together, more than ever, to maintain first place.

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We firmly support the Administration's general economic recovery plans, including reduction of government spending. Within the guidelines of the Administration's plans it is appropriate to adjust priorities to best serve the nation's interest. Within these guidelines, therefore, we strongly urge preservation of the NASA Aeronautics budget, including programs for propulsion research and technology.

Mr. GLICKMAN. Thank you, Mr. Shank.

Mr. Donohue.

STATEMENT OF THOMAS DONOHUE, GENERAL MANAGER, ADVANCED ENGINEERING AND TECHNOLOGY PROGRAMS DEPARTMENT, AIRCRAFT ENGINE BUSINESS GROUP, GENERAL ELECTRIC CO.

Mr. DONOHUE. Mr. Chairman and members of the committee, propulsion technology, especially engine technology, is a very significant driver in the generation of improved aircraft.

Great improvement in fuel consumption of our more recent airliners has been the result of both airplane and engine technology advancement. The amount of fuel required to fly a passenger from San Francisco to New York on the newest aircraft in 1985 will be about one-half that consumed in the early 1960's. The world's airlines buy the most attractive aircraft, principally those having the lowest overall operating cost, offered by the manufacturers. The best aircraft can be produced only by those having the capability to apply the best available technology.

New airplanes are huge investments, requiring many long years of successful sales before breakeven occurs and a positive return on investment reached. New engines can cost more than $1 billion to design, develop, and introduce once the basic technology is available.

In addition, when compared to aircraft, the development time for engines is longer and a proportionately greater amount of continuing development following service introduction is required.

As a consequence, it becomes extremely difficult for an engine manufacturer to sustain a full-scope research and technology, R. & T. program. We, and others, rely on Government agencies to start advancements and either directly participate as a contractor or at least have access to Government-sponsored activity throughout industry, military labs, and the NASA centers.

The military is placing greater reliance on NASA's propulsion technology activity. Many current activities are considered vital to the success of future military propulsion systems. Among these is the fundamental understanding of the introduction of components which cause what is known as "stagnation stall," a particularly damaging state which is occasionally encountered in gas turbine engines.

Other areas addressed include modern control theory, vibration and flutter of airfoils, and composite structures. The list goes on—small engine components for Army helicopters, subsonic system fuel consumption reduction for airlift or maritime patrol—"convertible engines" for very high-speed-attack helicopter concepts. But perhaps the most important of all for my interpretation of military needs is the activity addressing the complex characterizations of fluid flow, heat transfer, and structural behavior in aircraft engine combustor and turbine components. The United States needs NASA to pursue exploratory work in aeropropulsion research which may have applicability to military aircraft, but is not bound up in a military system requirement.

Our historic point of competition has been from Rolls-Royce. Rolls-Royce has had joint ventures with European partners in France and Germany over many years. But the initiation of a new partnership to pursue what might become a most important product, an engine for the potential 150-passenger airplane, is of special interest. The engine program is called the RJ500, wherein Rolls is joined by a Japanese consortium of powerful industrial companies to develop and ultimately produce the engine.

Of course, Rolls participation is backed by the British Government. But of greater significance is the role of MITI in financing the Japanese side. MITI [the Ministry of International Trade and Industry] will provide approximately two-thirds of the funds required for the development of the engine. The Japanese Government has decided that Japan will be a participant in the worldwide aircraft engine industry.

Foreign competition will continue to intensify. Foreign governments and industry have joined to centralize aeronautical research and technology development either by or through agencies similar to NASA. The NASA aeroindustry partnership, unique among U.S. Government and industry relationships, is necessary to continuing the flow of technological advancement in order to assure U.S. competitiveness. This partnership is based on the mutual interest in doing the job better and on the mutual technical respect.

What is NASA's role in aeronautics? In my view, NASA's role is one of supplying seed money—but not the supplier of venture capital—in the wide ranging areas of aeronautics technology. NASA has a most important opportunity to foster new and interesting ideas—the innovations—within the entire aeronautics community. Some will be self-generated, some should be encouraged by supporting high-risk/high-payoff programs with contractors.

Disengagement from any of the fundamental areas of aeronautical technology would ultimately prove damaging to the aviation industry. A diminishment of technological growth in propulsion would both slow and decrease improvements in airplanes. As the potential for improvement in engine technology exists, someone, someplace, will develop it.

For many years, the United States has been dominant in world aviation by guilding on the research and technology supplied by both the military and NASA. The Europeans and Japanese have decided to become major factors in the aircraft engine business by investing in modern facilities and performing intensive R. & T. efforts and by supporting product development.

We cannot stop them, but we can learn through the experience of other industries such as steel, automotive, and even high-technology electronics. Seemingly, the best approach to deflecting serious inroads is to keep renewing our technology base and maintain a measurable technology lead. A strong and vital NASA, with emphasis on the first A, is a critical part of this approach.

[The complete prepared statement of Mr. Donohue follows:]

STATEMENT BY

THOMAS F. DONOHUE

GENERAL MANAGER - ADVANCED ENGINEERING AND TECHNOLOGY PROGRAMS DEPARTMENT

AIRCRAFT ENGINE BUSINESS GROUP

GENERAL ELECTRIC COMPANY

BEFORE

SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

COMMITTEE ON SCIENCE AND TECHNOLOGY

U.S. HOUSE OF REPRESENTATIVES

DECEMBER 8, 1981

Mr. Chairman and Members of the Subcommittee:

I am Thomas F. Donohue, General Manager of Advanced Engineering and Technology Programs Department of the Aircraft Engine Business Group of the General Electric Company. As a member of the aeronautical technology community and having familiarity with NASA efforts in aeronautics research and technology, I am appreciative of this opportunity to discuss the first "A" in NASA, the role that NASA has played and should play in aeronautics. Since my background is propulsion, my commentary is primarily directed toward that aspect of NASA activities.

Propulsion is a high technology activity encompassing the integration of the airplane and the engine. Aircraft engine design and manufacture is a high technology business directed at providing safe, reliable transportation for the public and superior performance characteristics for the military. The modern high performance aircraft engine is probably man's highest technical achievement in the application of the mechanical arts and sciences to machinery. It is at the leading edge of technology in the design of efficient aerodynamic structures operating in severe environments for many thousands of hours and the manufacture of complex shapes from exceedingly difficult materials. Modern engines are complex and expensive; yet, they are economically viable because their high performance allows the design of highly efficient and productive aircraft. The aircraft engine business has grown during the "jet age", and the bulk of it is located in the U.S.

Propulsion technology, especially engine technology, is a very significant driver in the generation of improved aircraft. For civil transports a 15% reduction in engine fuel consumption provides about an 8% reduction in airplane direct operating cost. Similarly, a 15% reduction in engine weight in a high performance fighter airplane would result in a comparable reduction of airplane gross weight, a parameter often used as an indicator of basic airplane cost. The great improvement in fuel consumption of our more recent commercial airliners has been the result of both airplane and engine technology advancement. The amount of fuel required to fly a passenger from San Francisco to New York on the newest aircraft in 1985 will be about one-half that consumed in the early sixties. The world's airlines buy the most attractive aircraft, principally those having the lowest overall operating cost, offered by the manufacturers. The best aircraft can be produced only by those having the capability to apply the best available technology.

For nearly half a century much of the key technology leading to U.S. preeminence in the civil airliner market has come from NASA or its predecessor, NACA. An early and very important example was work done by NACA in the 1930's on propellers and cowlings for radial engines. The understanding of the integrated systems drag and generation of low drag cowling shapes allowed the application of the advanced radial engines developed by Curtiss-Wright and Pratt and Whitney to high speed fighters and fighter bombers of World War II. These engines with their efficient cowlings were ultimately developed to where they powered land-based Douglas, Lockheed and Boeing airliners capable of non-stop intercontinental passenger service. These airplanes resulted in U.S. dominance of the world airliner market.

During the late '40's and early '50's the NACA performed basic component research on the major components of the newly invented jet engine. Much of it was the understanding of the aerodynamic performance of turbomachinery. Of great value was the generation of compressor airfoil cascade data which led to the dominance of small diameter axial type compressors and lower drag airplanes. The Series 65 airfoil shape developed at this time proved to be outstanding and remained a standard for many years. Thus, NASA basic technology, especially in aerodynamics, allowed the development of important new jet engines by industry under the auspices of the military services.

From the mid '50's to the late '60's NASA's role in what became extensive military development programs was of secondary nature. In the late '60's a reawakening of interest in propulsion systems and engine technology occurred. This NASA thrust was not as heavily oriented toward basic research as much as toward improved performance and the important peripheral technologies relating to environmental issues. The thrust in the '70's is typified by a program performed by General Electric called the Quiet Engine Program which systematically investigated the acoustic performance of modern fan components and acoustic treatment (....noise suppression techniques) for the then new high bypass turbofan engine concept.

Throughout the '70's NASA supported many technology programs. General Electric performed as contractor on a substantial number, including investigations into highly loaded fan turbines, highly cooled turbines, combustor emissions, the applicability of composite materials into major engine and nacelle structures and new and improved airfoils for compressors. In each case the cited key technology elements have found their way into product application. For example, the highly loaded fan turbine certified in the CF6-80A this past October is derived from the technology exploration initiated under a NASA program in 1971. This component saves fuel, consumes less strategic material and is more quiet; thus keeping our products most competitive on the world market.

The oil embargo of 1973 and subsequent dislocation of oil prices intensified industry efforts to explore means of reducing aircraft fuel consumption. NASA responded with a number of technology programs for both aircraft and engines. The largest of these is known as E^3, the Energy Efficient Engine Program, in which GE and Pratt and Whitney are committed to technology development demonstrating a 15% reduction in fuel consumption over currently used wide-body propulsion systems. General Electric is pleased to be a participant in this program and expects to demonstrate the fuel consumption goals next year.

New airplanes are huge investments requiring many long years of successful sales before break-even occurs and a positive return on the investment reached. New engines can cost in the order of a billion dollars to design, develop and introduce once the basic technology is available. In addition, when compared to aircraft, the development time is longer and a proportionately greater amount of continuing development following service introduction is required. As a consequence it becomes difficult for an engine manufacturer to sustain a full-scope Research and Technology (R&T) program. We, and others, rely on Government agencies to spur advancements and either directly participate as a contractor, or at least have access to Government sponsored activity both in industry and the military labs.

Major new military aircraft systems - be it weapons, airlift, trainer - are becoming less frequently introduced. Even then, except for the initiatives of DARPA and certain critical weapons systems, there is a tendency toward "conservatism" - a reduction in risk taking even if there could be high potential payoff. We are seeing a continuing trend of focusing applied research and technology into planned or perceived weapons systems wherein requirements are specified. This is at the expense of experimental work. Indeed, I can't recall an experimental airplane being built by the services since the early post World War II time period. What has happened is that partnerships are formed between one or more services and NASA. NASA has the unique capability of doing flight research. A diminishment of NASA's capability would force the services to perform that function and funds would have to be provided.

Research and exploratory development on the part of the military has eroded in all disciplines of aero propulsion technology. An example is USAF propulsion expenditures for this activity wherein some $29 million was applied in fiscal year 1972 and one decade later the amount is $53 million. If one escalates the '72 funding using a composite index pertinent to the engine industry we find that $29 million becomes $69 million. In other words, the Air Force spent 30% more in "leading edge" technology in 1972 than they are spending in 1981.

The military is placing greater reliance on NASA's propulsion technology activity. Many current activities are considered vital to the success of future military propulsion systems. Among these is the fundamental understanding of the interaction of components which cause what is known as "stagnation stall" a particularly damaging state which is occasionally encountered in gas turbine engines. Another area addresses modern control theory as applied to engines and their potential integration with the aircraft itself. Still another is the investigation of flutter and forced vibration as applied to compressor airfoils and then to combinations of airfoils and disks. Composite structures for lower temperature components is of significance because of their weight and cost reduction potential.

The list goes on....small engine components for Army helicopters.... subsonic propulsion fuel consumption reduction for airlift or maritime patrol...."convertible engines" for very high speed attack helicopter concepts. But perhaps the most important of all from my interpretation of military needs is the activity addressing the complex characterizations of fluid flow, heat transfer and structural behavior in aircraft engine combustor and turbine components. The U.S. needs NASA to pursue this exploratory work in aero propulsion research which may have applicability to military aircraft, but is not bound up in a military system requirement.

The industry faces an ever-increasing challenge from foreign competition. In the engine area we find that investigations into the fundamentals of fluid flow and many other areas performed in European countries and Japan are comparable to our own. Basic research is widespread around the world with expert theoreticians and mathematicians working hard on fundamental issues. Foreign technical papers presented at technical meetings - even those held in the U.S. - on these fundamental issues exeed in number, and often in quality, those delivered by the U.S. But we don't know as much about activity in applied research and technology development. It seems that most foreign countries are relatively reticent about reporting research which expresses means of "doing things" produced by or through their governmental agencies comparable to NASA.

These agencies provide facilities quite comparable to NASA's although not as broad in scope. In most cases comparable wind tunnels are available. We at GE do use their facilities because they are more modern and available. They do not yield "better" data but have newer data acquisition systems and have higher productivity and are, apparently, unconstrained by energy budgets.

Our U.S. historic foreign competition from overseas has been Rolls-Royce. Rolls has had joint ventures with European partners in France and Germany over many years, but the initiation of a new partnership to pursue what may become a most important product - the 24,000 lb. thrust class engine for the potential 150 passenger airplane - is of special interest. The engine program is called the RJ500 wherein Rolls is joined by a Japanese consortium of powerful industrial companies to develop and ultimately produce the engine. Of course, the Rolls participation is backed by the British Government, but of greater significance is the role of MITI in financing the Japanese side. MITI, the Ministry of International Trade and Industry, will provide 75% of the funds for the first development engine, 67% of the funds through the basic development which culminates in flight test, and 50% of the final phases of development. The Japanese Government has decided that Japan will be a participant in the world wide aircraft engine business.

Foreign competition will continue to intensify. Foreign governments and industry have joined to centralize aeronautical research and technology development either by or through agencies similar to NASA. The NASA aero industry partnership, unique among U.S. Government and industry relationships, is necessary to continuing the flow of technological advancement in order to assure U.S. competitiveness. This partnership is based on the mutual interest in doing the job better and mutual technical respect.

What is NASA's role in aeronautics? In my view NASA's role is one of supplying "seed money" - but not the supplier of "venture capital" - in the wide ranging areas of aeronautics technology. NASA has a most important opportunity to foster new and interesting ideas - innovations - within the entire aeronautics community. Some should be self-generated, some should be encouraged by supporting high risk/high payoff programs with contractors. More specifically:

> NASA should be the key U.S. source of aeronautics research. One aspect of this research, the computer modelling of physical phenomena pertaining to aircraft, such as fluid dynamics and structural analysis, is of critical importance.

NASA should independently pursue applied research and technology regarding components, or subsystems, or system configurations for both air vehicle and propulsion where large potential payoff may exist. Council with both industry and the military should be maintained.

NASA should provide modern and efficient facilities for applied R&T for both their own independent programs and in support of industry initiated programs and ideas.

NASA should provide opportunities for U.S. industry to show by practical demonstration that an innovation or a technological advancement may have applicability for development into a product.

NASA should be a U.S. resident body of technical expertise and perform as the focal point for data related to aeronautics technology and assure domestic availability of such national assets.

Disengagement from any of the fundamental areas of aeronautical technology would ultimately prove damaging to the aviation industry. For example, propulsion technology has great leverage on aircraft improvement ranging from one-third of the potential for transport types to two-thirds of the potential for high performance vertical lift systems. A diminishment of technological growth in propulsion would both slow and decrease improvements in airplanes. As the potential for improvement in engine technology exists someone, someplace, will develop it.

For many years the U.S. has been dominant in world aviation by building on the research and technology supplied by both the military and NASA. The Europeans and Japanese have decided to become major factors in the aircraft engine business by investing in modern facilities and extensive R&T efforts, and by supporting product development.

We cannot stop them, but we can learn from the experience of other industries such as steel, automotive and even high technology electronics. Seemingly, the best approach to deflecting serious inroads is to keep renewing our technology base and maintain a measurable technology lead. A strong and vital NASA with emphasis on the first "A" is a critical part of this approach.

Mr. GLICKMAN. I want to thank you all for your testimony. I think that you have answered many of the committee's questions.

I think Mr. Steiner's initial statement made the statement that the danger is, as much, the complacency we have is built on successes in the past. And I think that is part of the issue.

But the other thing I would like to say is that the cooperation between your industry and the Government is really unparalleled in America, and it is what has served as a model for what is now happening in the rest of the world. And what worries me is that this administration may have itself in an ideological straitjacket, where it is incapable of understanding that that fundamental relationship is what has moved us along so successfully.

And so I would ask you—you've made some pretty strong statements today—are you willing to go to bat for this—with the administration? Because many of you have been strong supporters of the President's program, are you willing to go and relate these—you said them on the record here—to folks in the administration, to let them know the significance you think this has to our national economy?

Mr. STEINER. Mr. Chairman, within the limits of comments that are contained in the testimony, I would say that I believe any of us are willing to state the truths that we observed in this testimony to anyone in the administration.

If that is not correct, I would like to be corrected. [Others concur.]

Mr. GLICKMAN. Very good.

Mr. STEINER. That is basically correct. We would be willing to state there are a few things that have to be observed. We can't perform miracles. But, yes, the answer to your question is basically yes.

Mr. GLICKMAN. I'm talking about a theme. We may have to accept a period of nonsubstantial growth. And we know that there are some realistic budget problems. We're not coming here asking for big increases. I know that is not realistic. What I am worried about is that we're going to lose our theme here, and that worries me very much. And I think that is what all of your testimony has indicated today.

You talked a little bit about what some of the other governments are doing. Do you see, in this era of enormous capital costs, let's say, Japan or West Germany, or a European consortium making significant achievements in technology development that we cannot achieve with the level of our research efforts? Do you see that if we, in fact, let our NASA research efforts go down that if this trend continues or if we cut it in half, as OMB as proposed, is it a practical, realistic possibility that we'll be nudged out in terms of the next generation of aircraft?

Mr. STEINER. Tom, do you want to take that one on?

Mr. DONOHUE. I think we should be very concerned with the Rolls-Royce–Japanese program, because the success of American engine business has largely been one of not only technology but relatively high-operating efficiencies in producing engines at reasonable cost. And Rolls-Royce has not been as productive as have the American companies.

But when you match though the high technology available at Rolls-Royce with the extremely advanced manufacturing potential that would exist in Japan, that type of technology, I think you have a very, very strong combination, which certainly could produce a product. And in the long term, I think the Japanese could be very effective in producing aircraft engines at a very low price.

Mr. GLICKMAN. Mr. Shank, do you have a comment?

Mr. SHANK. Yes, I would like to make a comment, Mr. Chairman.

There is no question but that the Japanese have a very high capability in technology. I think that is evidenced by their past record.

Additionally Rolls-Royce has an outstanding understanding of the market, combined with a good technological understanding. Consequently, Rolls-Royce working with the Japanese constitutes a significant threat.

The next most probable advance in propulsion which will provide a significant increase in performance; that is, a sizable reduction in fuel consumption, is the advanced prop fan. And if this work turns out to be the next great innovation in modern aviation the eventural product developed from the technology may very well dominate the aeronautics world market of the 1990's.

If we do not pursue it in the United States through the NASA leadership that we now have, it is probable that the Europeans, or the Japanese through Government subsidy will pursue it—they're both capable of doing it—and have a product before U.S. industry does. This would result in their domination of the commercial market in the 1990's. Historically, he who gets to the market first with the best product will dominate.

Mr. DONOHUE. Specifically with regard to the prop fan, they're pursuing a vast amount of development in France.

Mr. GLICKMAN. Taking that to a more general level, Mr. Schaufele indicated here—and I want to make sure there's some general consensus on this—that NASA needs to address not only basic research items, which is the fundamental part of its budget, but it should also have substantial technology development in there so that it finds its way into something useful.

Mr. SCHAUFELE. Yes.

Mr. GLICKMAN. Do you believe, that NASA has a role in more than just the long term basic research and development? It has also got a role in systems technology work, in cooperation with industry.

Mr. CLEVELAND. A good example of that is an area that is still very uncertain as to whether or not it will ever be perfected, and that is laminar flow control.

And the interaction of the structural development, the propulsion system itself and the aerodynamics of the surfaces that you're dealing with all have to be dealt with simultaneously or you have nothing. Whereas, the basic researcher would just be working the removal of boundary layer air.

Mr. GLICKMAN. OK.

Mr. STEINER. Mr. Chairman.

Mr. GLICKMAN. Yes.

Mr. STEINER. I might make a statement that would cover for the air frame, since you heard the propulsion people.

Mr. **Glickman**. All right.

Mr. **Steiner**. On the airframe side, there are very large improvements foreseeable in the future, and they are foreseeable by the United States, by Japan, by France, and Germany. And they are working on them.

Now, those improvements are perhaps not as basic as the airfoil development. In some cases, they cover such things as active controls. Active control technology is at least as far ahead in France as it is in the United States. In many places, France is viewed as a leader, along with Western Germany, in active control technology. Composites are another. There's a whole series of these potentials and you get into a situation of integrating them. For example, active controls is a marriage situation that also involves electronic and aerodynamic advancements.

Now, it is my view that the three foreign nations we have identified—for instance, France, Germany, and Japan—are just as capable of developing these areas as we are. And the momentum that we perceive in those three areas is far higher than ours. So that if we simply let time go by, we will be, as you said, nudged out.

Mr. **Glickman**. I would like to ask it. You made reference in prior testimony to things like the Eximbank, which, of course, the airframe manufacturers use quite extensively, and whether we ought to perhaps, if we had to make a choice in priorities, reduce funding to the Eximbank a bit in order to perhaps find the money to fund adequate research and development.

Perhaps Mr. Steiner, might want to comment on that.

Mr. **Steiner**. Well, I'll give you two answers:

The first one is that it sounds, to me, sort of like a doctor saying to the patient: "You've got tuberculosis and early cancer. Which do you want to be treated for?"

The other one is that presumably the use of taxpayers' money should be amplified or whatever. It should be considered wherein that use is cost effective, particularly in the creation of jobs and the creation of an industrial base.

In other words, what value, what multiplication factor do we get for the use of Government money? We shouldn't, I would think, use Government money on a 1-to-1 multiplication. We should expect a very large multiplier in the economy and in the tax base. I would perceive both the Eximbank and NASA as having such a very large multiplier, in terms of jobs and value to the economy, of a given Government dollar.

As to priority between the two, I doubt that anyone on this committee would want to simply say priority A and B at this time. I think that is a very hard question for us to answer. It isn't within our expertise. But certainly I think if anyone wishes to corroborate my comment on cost effectiveness, I don't see how you can get much more cost-effective money than investment in NASA.

The NASA benefit has a long-term cost effectiveness, and the Exim has a near-term cost-effect. They're both cost-effective for their respective timeframes.

Mr. **Glickman**. We don't want to engage in protectionist environment. And at the same time, the Eximbank provides some sort of competitive financing arrangements as other countries have. But

Mr. Dunn did want to ask the question, at least to get it on the record.

I would like to ask Mr. Cleveland—I just flew in this morning from Florida, and I flew a Lockheed airplane, a very comfortable ride. But I noticed, in reading the Atlanta Constitution, that you were going to stop producing the 1011's.

To what extent, if you can, do you attribute that to, let's say, fundamental Government commitment in the research and development area and the reduction in commitment?

Mr. **Cleveland**. I can't relate the two at all.

If my colleagues will permit me to say so, the 1011 is acknowledged to be at least one of—if not the—most advanced technological transports flying today. And therefore, it is not due to lack of research and technology in that airplane—which, I remind you, was originally laid down in about 1969. The technology dates back to that point in time.

The problem is one of the market. And it is a very involved one, as I am sure you read in the article. I am not competent to speak to all of the elements.

However, it is pretty clear that by some unknown percentage European commercial aviation is going to be higher today than it was yesterday as our 1011 program concludes over the next couple of years. Somebody is going to be buying airplanes someplace. And based on reasonable assumptions, you would expect that some of the market that the L-1011 airplane might have covered may be taken by European firms.

Mr. **Glickman**. Well, specifically, you take the air bus. The air bus has in the past, and may in the future, take some of that market.

Mr. **Cleveland**. One would expect so.

Mr. **Glickman**. I would like to ask a final question and turn it over to Mr. Harkin.

The administration has argued that its program of tax cuts are of more value to the industry than the support it receives from NASA.

Do you believe that industry would use the added income—that is, from the tax cuts, to achieve the same results as would have been the case under NASA?

Mr. **Steiner**. Well, answering it in part—and with the recognition that I certainly am not, and I doubt that others at the table are experts in the tax bill—the value to a significant segment of U.S. industry of the tax cuts, when placed on an R. & D. basis, is not very high. In other words, the stimulation of R. & D. that is inherent in that bill doesn't give R. & D. in our company any particular assist. We don't get any out of it, as far as I know.

So that I guess I would have to say that, quoting our chairman, "we should exchange our savior policy for a winner policy," and with the implications that might have on R. & D. stimulation. My belief is that the stimulation that we get from NASA probably cannot be attained in-house. It is a national stimulation. It is a competitive stimulation.

I, for one, very much rue the stopping of the 1011, because I was happiest, from a Boeing standpoint, when we were fighting for our lives between Boeing, Lockheed, and Douglas. And that made a better machine for all of us. And together, we took a larger share of the world market. Separately, we will not.

And so, I guess I feel that the NASA role cannot be done by industry, regardless of the tax mechanism used. And as I point out, the tax mechanism used in the Boeing case for R. & D. stimulation is not particularly effective.

Mr. GLICKMAN. Again, Mr. Cleveland.

Mr. CLEVELAND. The tax relief, of course, applies to increases in certain development costs. And if you increase, you will get some tax benefit. But, as Jack says, it's not very large.

With regard to this competitiveness which you have alluded to time and time again--and we all have—I think there is a point that we sometimes forget, and that is that if a curve of our capability is crossed by another country's capability and you say, "Gee, they just passed us," it is far too late to rectify the problem.

The teams that do this kind of work, whether they are NASA teams or industry teams, are teams that have worked together and have relationships and interfaces—working relationships—that make a very, very complex web. And reassembling something like that after it has been seriously damaged due to the kind of thing we're talking about, is really tough. Playing that kind of catch up ball is about the toughest game in the world.

Mr. GLICKMAN. Thank you.

Mr. Harkin.

Mr. HARKIN. I appreciate you all taking the time to be here today to present this testimony.

I just wonder if there is something else that perhaps weaves its way through all of your testimony but hasn't really been focused in on? Maybe we tend to shy away from it, I don't know. But we all talk about NASA's role in aeronautics, but when you look at the amount of money that goes in, as compared to the private sector money that comes in, it is minimum. I mean, it is very small.

And so we say, well, maybe it is not just the money that is so important, there is something else beyond that that is important. And perhaps it is the idea that by involving an agency of the Government, by involving the Federal Government in this effort, we make it a national effort, we make it something that all of us have a stake in, that we all will support, all will tend to work for because it is not just an effort by McDonnell Douglas, by Boeing, Lockheed, Pratt-Whitney, or whoever. This is a national effort. This is something we all share in.

And perhaps that is probably as important as anything else from the standpoint of keeping this NASA involvement in aeronautics.

I just want you to think about that—think about that as a part of this picture, of keeping NASA involved, aside from all of the technical reasons, the reasons for support of a good R. & D. base. Aside from all that, just keeping a national effort going and not just having a McDonnell Douglas effort, a Boeing effort or something—is that fair?

Mr. CLEVELAND. Yes, I think so. There is something else NASA brings to the table. Once they have stamped a piece of technology as being valid by publishing a report—or whatever they do with it—it gives those data an international acceptability or a domestic airline acceptability, which is very important in many of the things that we do. It's a part of that whole common focus that they bring to so much of the aeronautics work.

Mr. HARKIN. Sure.

Mr. STEINER. I believe, Mr. Harkin, we might reiterate the concept of the body of technology that supports the industry. NASA is able to take a block here and a block here, and industry put a block there, and even some of the foreign people put blocks here and there. That body of technology has to support both the military and the commercial efforts of this country.

Now, it has to support those of the other nations as well. However, our experience—at least my own, in 40 years—is that the only way you get ahead in this industry is by running faster. And so if the combined national and industry and academia sources can run faster, the Nation will, in fact, be better off for that.

Now, the alternate, if you take one of those three members—or one of the four members, if you include DOD—and diminish, as we have done, our combination will not run as fast. And in the long term, then, the other guy will get ahead.

Mr. HARKIN. Thank you.

Mr. GLICKMAN. I want to thank the panel for their excellent statements. I don't think that I have heard any series of better and more in-depth statements by an industry panel before. And I think you all should be proud of the position that you have taken, together with the quality of the material which was presented for us today.

Thank you very much.

Mr. STEINER. Thank you, sir.

I might mention that I think many of us are surprised, after all of it, how mutually reinforcing our statements came out to be.

Mr. GLICKMAN. Our last witness, and not least, is Mr. Guy Stever, chairman of the Assembly of Engineering, National Research Council. He has done an extensive amount of work on this particular issue and his efforts have been not only appreciated by this committee, but in many cases have been responsible for some of the actions the committee has taken in the area of aeronautics.

It is a pleasure to have you here. You may feel free to summarize your statement. It will appear in its entirety in the record.

STATEMENT OF H. GUYFORD STEVER, CHAIRMAN, ASSEMBLY OF ENGINEERING, NATIONAL RESEARCH COUNCIL

Dr. STEVER. Mr. Glickman, thank you very much.

First of all, I appreciate the opportunity to appear here. I would like to endorse many of the statements that have been made before, especially on the quality of NASA, our military aeronautical effort, and our aeronautical industry.

I would say that while the statements about the nature of the friendly commercial competition and the military threat were very strong, I feel that they may have understated the case.

I also think there is a great deal to be done in aeronautical science and technology. And I agree with some of the statements that all of the aircraft sold in the future will depend on technology to be done and not necessarily on what has been done.

Something else hasn't been emphasized very much here in the discussion, although you brought it out a little bit. That is the question of industry taking on a greater share of this load—the industry versus Government argument, which is being sharpened and oversimplified, in my view, today and in the recent past.

Actually, the research and development program of the United States has steadily shifted from Government support to industry support. In 1967, I think it was, the Government supported 60 percent of all the R. & D. done in the United States—that is, not only aeronautical but all R. & D. Industry supported only 47 percent. Today, a decade and a half later, industry has gone from 35 percent to 49 percent. And Government has gone from 60 to 47. That shift is taking place; the question is not whether it is desirable, but how rapidly it can be done and in what areas should we do most of it? In what areas should we not make this shift?

So, I think the problem today is really to figure out what is the most efficient way of addressing our aeronautical problems today and in the next couple of decades.

Now, the National Academies of Sciences and Engineering, and the Institute of Medicine, through their National Research Council, were asked to put together a team.

When you asked me to testify today, since I previously testified in Congress on the results of that, I got out a report, which is now approaching 1 year old. And I discovered it holds today——

Mr. GLICKMAN. Is this the report?

Dr. STEVER. Yes, it is.

Mr. GLICKMAN. National Aeronautics report workshop?

Dr. STEVER. Yes; we would appreciate it if that were entered, along with my written testimony.

Mr. GLICKMAN. Yes; it has been entered before. We have it in our committee records, too.

Dr. STEVER. Thank you very much.

I would like to summarize a bit of our workshop's results.

First of all, the question was defined very precisely: What is industry's opinion about what NASA's role should be? And I don't mean just the statements of NASA. It's been great since 1950. We all know that. We all believe it. But let's look at today's problems, today's strength in NASA, today's strength in industry, today's competition abroad, today's military threats abroad, and so on. Let's look at today and find out what is best for this country today.

And we put together a team that included some of the people who have already testified. They were 60 leading people from the field of transport aircraft, military aircraft, rotorcraft, and general aviation. They were not selected because of their industrial or institutional alinements, but simply because these were people who had lived lives and contributed in those technical fields.

We had some academic people and some from other industries, such as steel, autos, and electronics. We had people from the military services and from the FAA. And all of these people participated. Congressman Harkin came to give us one of our talks. All of these people were volunteers, but they were tremendously dedicated.

And from my point of view—I had dropped off a little bit in following the aeronautical field, in which I spent many years of my life—I was fascinated to see the unanimity that came out of that discussion.

You recall that we got down to details and picked possible roles for NASA to play, from understanding basic phenomena to developing technical concepts, to designing and constructing vehicles or new operational systems.

And included in our possible combinations was that in which NASA might simply be the caretaker of the superb aeronautical facilities it has designed, constructed, and used for the benefit of industry and the military.

By the way, the workshop panels also reviewed possible alternatives to NASA for the continuing aeronautical R. & D. program in this country. They considered collaborative practices among the industries and other organizations, and also turning a part or all of this over to the armed services or the universities. And none of these were either wholly or substantially a substitute or replacement for NASA in what they did. The fact that NASA has worked so well with all of the members of the aeronautical community has been a very strong advantage in the past, and will continue to be so in the future.

There is one other thing to consider. NASA, in aeronautics, has only one mission, and that is to get the R. & D. to back up other agencies. No other other organization that you can think of has only one mission.

Industrial organizations have other missions; they've got to build the things and sell them and compete in their particular segments of the market. That is a very important feature of NASA that has to be brought up.

Clearly, the Department of Defense has great capabilities in aeronautical research and development, and they'll continue to exert these. On the other hand, there are differences between what the military wants in aeronautics and what we need in the commercial field over all these different things as well.

From my perspective—and here is my summary—I saw three major conclusions coming out—the various sectors of aviation very clearly endorsed the view, by so overwhelming an endorsement that we didn't even have to take votes on it, that the Government cooperation by NASA has stimulated them in the past. They will need it in the future.

With regard to the fundamental question about what the specific roles are, there was unanimous agreement that NASA should be engaged fully in research and the development of advanced technology.

Another role for NASA should be technology demonstration and validation when it is determined on a case-by-case basis to be of benefit to the country.

Apart from these specific roles, the workshop identified several potential new roles for NASA: Providing a technical data base for use by the FAA in aircraft air-worthiness certification, helping solve the problems of decreasing numbers of U.S. graduate students in aeronautics, and disseminating information on foreign aeronautical research and technology to U.S. users. That last one I feel is a very important one.

We think that instead of being here in another forum, or forums, discussing whether NASA has a role, this country should come out with a very clear statement of the importance of aeronautics and of what the Government role is, highlighting the central NASA position in that.

Thank you.

[The complete prepared statement of Dr. Stever follows:]

December 4, 1981

STATEMENT

of

H. Guyford Stever
Chairman, Assembly of Engineering
National Research Council

Mr. Chairman and Members of the Subcommittee

It is a pleasure for me to meet with you, today, on a matter that I consider to be of great importance, i.e. the distinct possibility that NASA may not be permitted to continue its role and relationships in aeronautics with industry, universities, and other government agencies. Beginning with the establishment of its predecessor, the National Advisory Committee for Aeronautics, and continuing to the present, the NASA role and relationships have enhanced and promoted the transfer of new and advanced technology to the industry, and have been a key factor in the U.S. ability to attain its preeminence in aviation in the world today. At your hearing on NASA's authorization bill last February, we described the activities and summarized the conclusions and recommendations of a workshop on the role of NASA in aeronautics conducted by the Aeronautics and Space Engineering Board of the National Research Council.

That workshop was held in July 1980. In November 1980, we had a national election and in January 1981, we installed a new administration.

Now, in December 1981, the national outlook is changed, economically, socially and with regard to our foreign relations; but with regard to aeronautics and the aviation community, the conclusions and recommendations of that workshop are, perhaps, more pertinent today than when they were developed in July 1980. An overriding consideration now is that NASA cannot implement the role(s) recommended by the workshop. To do so would require significantly increased resources (funding and manpower) e.g. to acquire and upgrade facilities, to acquire, maintain, and operate research aircraft, and to support a strong post-graduate fellowship program. Under the budgetary situation it now faces, NASA must either choose among the recommended roles and not undertake some or, attempt to support all of them to some extent. This situation points directly at a basic issue of what extent NASA is to be supported by the Administration and at an even larger issue of what extent, if at all, the government must support the aviation industry.

In light of the critical nature of these issues and their serious implications for the future of U.S. aviation, it is particulrly timely to have this hearing. Today, I would like to take the opportunity to talk about what I feel is the further meaning of the Academy workshop in the context of the current situation..

You will recall that the workshop brought together from around the country, for a full week, 60 very busy people, all on a volunteer basis. The majority of these people were from the aerospace industry. A substantial number were from academe, and a few were from other industry, notably steel, automotive, and electronics. The 3 military services, DoD, and the FAA also participated. To me, this fact, coupled with not only the willingness to take the time to be a part of the study, but the dedication to the task and the enthusiasm exhibited by these people, demonstrates in a very real way the importance of the task we now face in making critical decisions that can have serious and far-reaching implications for the future of this country.

Aeronautical progress is vital to this country--for balance of trade, for effective transportation, for the economy and for national security. The U.S. aeronautical community must be able to function in a national and international environment that is changing rapidly and that threatens the very foundation of the preeminent position that this nation has achieved in world aviation.

Apart from budgetary, regulatory, and other constraints that have affected the nation's research and development infrastructure, most changes have occurred worldwide, as some nations rebuilt their industrial base to become viable competitors and, indeed, to attain a larger number of leadership positions in markets formerly dominated by the United States.

Aviation has become increasingly affected in this process of change over the past decade. Recognizing the attractive potential of an expanded air transportation system, the European governments have emphasized shared responsibilities and collaborative government and industrial programs to overcome the competitive advantages of U.S. economies of scale -- most notably in human resources, in financing, and in research and technological development. Following the European lead, other countries have also included civil aircraft development and production in their national industrial plans. Japan, significantly, has established aircraft as a high priority in its national industrial plans, and has meticulously nurtured its advanced research toward civil aviation.

There also are significant changes affecting the position of the United States in military aeronautics. Today, the United States relies on the capabilities of its allies to complement its air power. Although most of the post-World War II aircraft, armament, and equipment of these allies have come from U.S. industry, the trends indicate that many replacement items are likely to be designed and manufactured either by individual countries or by foreign consortia. Some foreign countries have been improving their aeronautical research capabilities during the last 15 years. Today, their aggregate research facilities are comparable to those of NASA, and the resulting aircraft and missiles show their technology to be equivalent to that of U.S. designs.

To meet this challenge, the U.S. military air services depend upon a strong complementary aeronautical technology base in NASA, industry, and academe to supplement their own efforts. Aeronautical technology developments by NASA are vital to the performance of the Defense Department's basic mission of defending the United States against any adversaries.

Today, there are in the wings, new technological advances in aerodynamics, in structures and materials, in electronics, and in propulsion that offer the potential for dramatic improvements in the efficiency of aircraft. Such improvements could make obsolete virtually all U.S. aircraft now in production or design. One decade from now, world leadership in aeronautics will be achieved, in all probability, by the nation or nations that seize the initiative and move such technologies from their present research status through the refinement and validation processes essential for the successful production and operation of more efficient aircraft.

The workshop addressed the manner in which the U.S. leadership in aeronautics has been attained. It turns out that NASA has provided a central technological resource that the U.S. aircraft companies drew upon to compete against one another. Out of their competitive battles, the inefficient were eliminated and the stronger companies emerged with a collective industrial strength that has produced the superior products with which the U.S. gained its world market dominance. In fact, such competition has been key in producing virtually all U.S. aircraft that have proven successful in world competition. I believe it is safe to conjecture here that NASA, in its role of providing research results and advanced technology for the use of all industry, creates and promotes an environment that makes such competition possible. Picture, if you will, a scenario in which there is no government facility such as NASA in aeronautics -- the emergence of a dominant manufacturer into NASA's role or, to a lesser extent cooperative or joint efforts between dominant manufacturers, could impair or destroy the benefits derived from domestic competition; or worse, the U.S. could succumb to foreign dominance of the field.

NASA's relationship with the various segments of the aeronautical community was cited by speakers during the first day of the workshop as being one that promotes the transfer of technology and the commercialization of advanced technology by the industry, and is the reason for the leadership in aviation that the U.S. presently enjoys.

You may recall that the workshop concentrated on eight possible roles for NASA that represent steps in the hierarchy of the research and development process, beginning with a desire for knowledge and an understanding of basic phenomena, an idea, or technical concept, and ending with the design and construction of a vehicle, a vehicle component, or a new operational system. Included was a role in which NASA (the Government) would do no more than maintain and operate NASA's aeronautical facilities for industry or other users.

The workshop panels also reviewed possible alternatives to NASA for conducting aeronautical research and technology development. They considered various collaborative practices for augmenting the capabilities of other organizations already engaged in aeronautical research in varying degrees, such as the aircraft manufacturers, the armed services, and the universities. None of these was thought to be wholly or even substantially a substitute for NASA. Indeed, that NASA and its predecessor, NACA, worked effectively and in harmony with the other elements of the aeronautical community for two-thirds of a century was considered to be a major strength of the present arrangement. NASA is unique in that its only mission in aeronautics is research; any other organization that would be a candidate to take over NASA's role has some other prime mission.

Substantial enlargement of the Department of Defense efforts in aeronautical research and technology development might enable it to become self-sufficient. But because the needs of civil aeronautical technology often diverge substantially from military aeronautical technology, civil aviation would not be well served by this approach.

The question of separating the aeronautical capabilities from NASA and forming a new and separate government agency was not considered by the workshop panels. It was assumed that roles in research and technology development would be no different if conducted by a separate government organization or by NASA.

The workshop participants noted that following World War II all units of the aeronautical community made a strong effort to build up their aeronautical research facilities until the increasingly prohibitive expense resulting from unwarranted duplication and overlap forced change. The balance in effort among the participating members of the aeronautical community that the United States now enjoys has been forged over the decades of the 1950s, 1960s, and 1970s and has brought important benefits to the United States.

The workshop participants collectively developed fifteen conclusions and recommendations pertinent to NASA roles and relationships in aeronautics in general.

From my perspective as chairman of the workshop, I saw three major conclusions emerging from the workshop which were cited in my letter officially transmitting the report of the workshop to the chairman of the Aeronautics and Space Engineering Board. I will conclude my remarks with a summary of those three points:

- The various sectors of the aviation industry that were represented at the workshop clearly endorsed the continuation of the present NASA-industry working relationship. The key point here is that government cooperation -- as exemplified by the NASA-aviation industry relationship -- can have stimulating and strengthening effect on an industry that can enable it to compete more effectively in the international marketplace and prevent its vulnerability to foreign trade offensives.

- With regard to the fundamental question that the workshop was asked to address concerning NASA's role in aeronautics, there was unanimous agreement that NASA should be engaged fully in research and the development of advanced technology. Also, NASA should be involved in technology demonstration and validation when it was determined, on a case-by case basis, to be of benefit to the country. Apart from these specific roles, the workshop also identified potential new roles for NASA -- (1) providing a technical data base for use by the Federal Aviation Administration in aircraft airworthiness certification; (2) contributing to the solution of the problem of decreasing numbers of U.S. graduate students in aeronautical science and engineering; and (3) disseminating information on foreign aeronautical research and technology to U.S. users.

- Finally, it was concluded that there is an urgent need for a clear and emphatic statement to reaffirm, clarify, and strengthen NASA's role in aeronautics, and such a statement should be part of a broad commitment to a strong national policy for aeronautics.

Before concluding these remarks, I would like to bring to the attention of the committee a particular problem having to do with the education and utilization of engineers. Although this was addressed by the workshop in terms of its effect on NASA and the aerospace community, it has implications that are more far-reaching. I refer to the problem of a shortage of doctoral level engineers. This is a result of a steady decline in the number of engineering doctoral degrees awarded by U.S. universities during the 1970s. For example, during this period, while the number of bachelor and master's degrees awarded in engineering were increasing, the number of doctor's degrees declined from about 3,500 in 1973-74 to slightly under 2,800 in 1977-78, a 19.6 percent decline.

Even more alarming is the steady decrease in the number and proportion of degrees earned by American students. During this same period, the number of U.S. citizens receiving doctoral degrees in all branches of engineering declined by 24 percent. The decline in aerospace engineering has been even more drastic until today about half of the doctoral candidates in the field are foreign nationals. This portends a future shortage of research workers for the nation's aeronautical and related industries and for NASA research centers. There is also a great need for doctoral engineers to fill faculty vacancies in our colleges and univerisities. I have seen estimates of this shortage ranging as high as 2,000 on a nationwide basis. This shortage of doctoral engineers can only worsen unless graduate engineering education can be made more attractive to the best qualified American undergraduates.

In the 1960s, a somewhat similar shortage of Ph.D. engineers was created by the expansion of the space program. At that time, NASA instituted an academic fellowship program that was successful in helping to replenish the supply of Ph.Ds., and other agencies adopted similar programs. However, funding for all such programs was drastically reduced in the early 1970s and it is my understanding that in order to meet currently proposed budget reduction mandates, NASA would likely have to drastically reduce its university fellowship support program. It was a recommendation of the workshop that NASA explore the possibility of rejuvenating its fellowship program as a means once again of helping to alleviate the shortage of doctoral engineers in the aerospace field. It occurs to me that, perhaps, it is time, as well, for the federal government to consider broader action to remedy the shortage of engineering faculty and holders of advanced engineering degrees. It has been estimated that between 1,000 and 2,000 two-year fellowships, funded at about $10,000 per year would be needed to overcome the shortage.

I hope my remarks have served to convey to this committee the sense of concern and urgency that was evident among all the participants who gave unstintingly of their time and talent at the workshop. I will reiterate that so many, willing to give so much in working on the problem of U.S. aeronautics, was an impressive indication that the industry and the academic worlds were deeply interested in the state of aeronautics and in what NASA should do about it. There is, no doubt, as well, that they were vitally concerned about doing their part to help. I sincerely hope that their effort will not be in vain.

Thank you.

Mr. **Glickman**. We appreciate your statement, as well as your work in the past. I am familiar with the workshop that was done, as well as your input on that.

As I said before, the specifics in there have been valuable to us as we marked up the NASA authorization bill. And by the way, I understand that will be up on the floor today for conference report on the NASA authorization bill, which, at least at this stage, if the House accepts it, does reflect some enhancement over what was initially proposed and hopefully will provide both the basic research and system technology base that we need.

But I guess my biggest concern is that we have had a successful model here for a long time, a model that shows how the public interest and the private interest can be melded together in our industrial base. And what worries me is that is being chipped away, not just because of fiscal issues, but because of ideological ones as well. And I have got to believe that in the long term it is that basic industrial base which the ideological perspective wants to enhance is going to be the one that is going to suffer.

The question is: What can we do to try to deal with that theme better up here or anywhere?

Dr. **Stever**. Well, I am glad you bring it up, because I think the dynamics of our country can stand many different approaches to solving its problems. In fact, if it is going to stay strong in the world, it is going to need them.

I don't think one can make a general statement that industry should take over all of our R. & D. We have to look at each case. I would not advocate a NASA for the automotive industry. They have an entirely different tradition. There I am really very sympathetic with fixing the tax laws and the competitive environment, things that Congress can work on to give the automotive people strength enough to do their R. & D.

In this particular field, we have a history of doing it this way. It has been copied by other nations. Many of those nations, you must remember, have centrally planned economies.

Many of my foreign associates in science and technology, in the Communist world and elsewhere, say that we should do more. What advantage do we have? What advantage do they have?

The advantage that we have is that, with our ad hoc, year-to-year arrangements, we can move into new areas quickly, and that is good, especially when things are going well so that we have the financial strength to move into them.

They have an advantage in that the centrally planned economies don't forget the long-term effort. And if they are threatening us, that is the biggest weapon they have, threatening in the sense of a military matter or threatening us in the sense of an honest economic competition. That is where they have the advantage.

The point was made, among my friends here, that NASA is providing a great deal of the long-term strength for this field. And I can't conceive of a way we could substitute for that, even if we get more work started in industry. Right now the industry is in a life-and-death, short-term competition. The companies will have to put the new assets they're going to get from tax changes—into short-term competition.

Mr. GLICKMAN. You know, I am always reminded, Senator Everett Dirksen once said, when asked what his basic principles were, did he have any, he said, "I am a man of principle. And my first principle is flexibility."

Let's hope that we are not locked up in a point of view without being able to move when we have to move.

I appreciate your testimony. And we appreciate the entire testimony.

We hope that these hearings will be useful in providing some support for the NASA functions and also for providing some feeling as to industry's part and the country's part.

This Congress believes that there is a strong, significant role for the Federal Government, a cooperative and positive partnership between industry and Government in making it possible to continue to, "dominate" the aviation industry.

Without any further comments, the hearing stands adjourned.

[Whereupon, at 12:25 p.m., the hearing was adjourned.]

Appendix I

Statement of Congressman Bob Shamansky

DRAFT STATEMENT FOR HEARING, "FIRST 'A' IN NASA"
CONGRESSMAN BOB SHAMANSKY
DECEMBER 8, 1981

MR. CHAIRMAN, MY FELLOW COMMITTEE MEMBERS, WITNESSES AND GUESTS:
IF WE FOCUS TODAY ONLY ON THE QUESTION OF RECOMMENDED BUDGET CUTS FOR NASA, IMPORTANT AS THAT QUESTION IS, WE WILL MISS THE LARGER ISSUE. THIS ADMINISTRATION AND CONGRESS RUN THE RISK OF UNDERMINING -- IN THE NAME OF BUDGET CUTTING -- ONE OF AMERICA'S INTANGIBLE YET CRITICAL RESOURCES. THAT RESOURCE IS OUR TECHNOLOGICAL PROWESS IN AVIATION AND RELATED FIELDS. FROM THE REALMS OF PURE RESEARCH TO PRACTICAL APPLICATIONS, WORK IN AVIATION TECHNOLOGY STRENGTHENS OUR ECONOMY, NATIONAL DEFENSE AND ADDS TO OUR STORE OF KNOWLEDGE WHILE CREATING NEW JOBS.

EARLIER THIS YEAR THE ADMINISTRATION ATTEMPTED TO PUSH THROUGH A FALSE ECONOMY, SAVING SOME TENS OF MILLIONS OF DOLLARS ANNUALLY BY ELIMINATING FEDERAL SUPPORT FOR SCIENCE AND ENGINEERING EDUCATION FURNISHED THROUGH THE NATIONAL SCIENCE FOUNDATION. FOLLOWING THAT COURSE WOULD HAVE MEANT PRETENDING WE DO NOT COMPETE WITH JAPAN, WEST GERMANY AND OTHER ADVANCED NATIONS IN INTERNATIONAL TRADE AND PRETENDING THAT MILITARY SECURITY CAN REST ON AN OBSOLESCENT TECHNICAL BASE. MANY OF US HERE RESISTED THAT MISGUIDED PLAN.

TODAY WE CONFRONT A SIMILARLY THREATENING PROPOSAL. THE OFFICE OF MANAGEMENT AND BUDGET HAS RECOMMENDED SEVERE SLASHES IN FUNDING FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. AERONAUTICS AND A MULTITUDE OF POTENTIAL SPIN-OFFS IN COMMUNCATION, ENERGY, EVEN AUTOMOBILE TECHNOLOGY COULD BE JEOPARDIZED.

The Administration seems to be denying the link its own spokesmen have pointed to between improved productivity and economic recovery, between America's Technological achievements and its national security. Where do productivity increases come from? Often from unexpected technological breakthroughs in research and development, from innovative application of laboratory achievements. In recent decades projects administered by NASA and funded by the federal government led to many such advances.

The Aviation industry is a good example. About 80 percent of the engines on all commercial planes flying in the world today are made in the U.S.A. All those engines in some way reflect work done by NASA, often at the Lewis Research Center in Cleveland. This connection between NASA and American Aviation and the importance of our aviation industry to our overall economic health and national security illustrate what is at stake. NASA already has felt the budget axe and many programs -- including the best known space operations -- have been cut. OMB's proposals now include closing the valuable Lewis Research Center.

In the coming years the Agency's role -- or lack of one -- in aviation and related research and development will help determine the success or failure of America's economic and even social renewal. If we intend to discuss seriously increasing national productivity and strengthening our military posture, examining the importance of "The First 'A' in NASA" makes a most logical

PLACE TO START. BILLIONS OF DOLLARS AND MILLIONS OF POTENTIAL JOBS MAY BE AT STAKE. CONGRESSMEN PEASE AND MOTTL AND CONGRESSWOMAN OAKAR WILL DISCUSS THE LEWIS RESEARCH CENTER IN MORE DETAIL. LET US REMEMBER THIS AFFECTS NOT JUST CLEVELAND OR OHIO, BUT THE NATION.

THANK YOU.

E.R.

Appendix II

Submitted Testimony*

AFL-CIO

LOCAL 2182

LOCAL 28

TESTIMONY FOR THE TRANSPORTATION, AVIATION, AND MATERIALS SUBCOMMITTEE OF THE HOUSE SCIENCE AND TECHNOLOGY COMMITTEE

DECEMBER 8, 1981

Congressman Glickman:

Thank you for the opportunity to testity to the Transportation, Aviation and Materials subcommittee of the House Science and Technologies Committee concerning loss of Energy, Aeronautics, and Automotive R & D and effects on the economy of the Cleveland area and Ohio.

As you know, the NASA Lewis Research Center plays a vital role in the prime areas of interest to your committee.

We wish to object to the proposed one billion dollar cut in the NASA Budget proposed for 1983 and 1984. The meat-axe approach to budget cutting may be politically expedient in the near term, but in reality will destroy a high technology base vital to the U.S. economy and national defense in the future.

The proposed cuts in aeronautics, in areas not related to military applications, will eventually cripple the commercial aviation industry which has consistently been a significant factor in reducing the balance of payments. Commercial aviation export dollars are second only to agricultural products. See attached figure "Aerospace & The U.S. Balance Of Trade". The proposed closing of Lewis Research Center in Cleveland is equally shortsighted. Closing Lewis Research Center would have a devastating effect on the economy and the supporting technology base of the greater Cleveland area. The impact measured in dollars taxes, and jobs was clearly defined by Mr. Gerry Sheehan, Executive Director of the Cleveland Area Development Corporation of the Greater Cleveland Growth Association, in testimony before the House Subcommittee on compensation and benefits at hearings in Cleveland on June 29, 1981. In addition, the closure of Lewis Research Center would destroy the only high technology research center left in Ohio. A national resource of unlimited value in the national defense scheme would be destroyed.

The proposed cuts in Applications would destroy the main benefit of NASA to the U.S. economy and the people of the U.S., that of technology transfer and technology utilization. The phrase "For The Benefit Of All Mankind" will no longer have any meaning.

The cancellation of planetary exploration by 1984 attributed to OMB Director Stockman is an example of the shortsightedness and ignorance of a man who measures all things in terms of dollars and productivity without regard to the long range benefit of building a scientific base of knowledge and high technology. It begins to become a dangerous situation when accountants and staff members or OMB assume the role of Congress and agency management in dictating policy and programs without the consideration of merit and the intent of Congress.

Since these proposed cuts can be measured in terms of a Nuclear Aircraft Carrier of 1.5 B-1 Bombers or possible 10 more ICBM's, would the U.S. truly be any more secure?

We initially present information concerning NASA's involvement in terrestrial energy programs which affect various modes of transportation.

NASA'S CURRENT ROLE IN TERRESTRIAL ENERGY

It is becuase of its in-place skills in the many disciplines associated with energy conversion R&T, coupled with the knowledge of project management that has been acquired over the years by its experienced staff, that NASA was requested to assist other government agencies in supporting various energy programs at an early date. For example, in 1972 the Lewis Research Center participated in the preparation of a NASA-NSF National Solar Energy Plan. In 1973, by letter agreement, Lewis provided significant support to the EPA Automobile R&T Program. Also, in 1973 NASA assisted in the preparation of an Atomic Energy Commission Energy Report to the President in which a National Energy R&D Program was recommended. Support of the NSF Wind Program followed in 1974, and with the subsequent establishment of ERDA, NASA support roles were defined further in a 1975 NASA-ERDA Memorandum of Understanding. These roles were reaffirmed in 1978 in a NASA-DOE Memorandum of Understanding.

Throughout the period of these events, NASA's role in supporting terrestrial energy R&T also was being prescribed in various legislative actions and/or amendments to the National Aeroanutics and Space Act of 1958. These included the Solar Heating and Cooling Demonstration Act of 1974, the Geothermal Energy Research, Development, and Demonstration Act of 1974, the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976, the Automotive Propulsion Research and Development Act of 1977, and others. Thus, today, NASA finds itself in a major support role for the Department of Energy in a wide variety of programs.

ADVANCED GROUND PROPULSION R&T

Work in advanced ground propulsion R&T for the Department of Energy is being conducted in two main areas; heat engines and electric vehicles. Work also is under way in vehicle systems and in diesel emissions control technology, all for the purpose of energy conservation. The heat engine work is focused on the development of new engines that might replace the conventional spark-ignition engine used in present day automobiles. The electric vehicle work is focused on advancing the state-of-the-art sufficiently to permit them to compete with other modes of transportation. (A third propulsion system being investigated, the hybrid vehicle combines a heat engine with an electric vehicle to extend the range of the electric vehicle.)

HEAT ENGINE WORK

The heat engine work is directed at two promising concepts as alternatives to the spark-ignition engine; the gas turbine and the Stirling engine.

These concepts were selected for further investigation from a number of alternatives after considerable detailed analysis and exploratory research. In particular, a 1975 study by the Jet Propulsion Laboratory with which the industry has agreed identified these two concepts as the most promising alternatives. Both engines offer the potential of multi-fuel capability, low emissions and improved fuel economy. Both are continuous combustion engines.

Multi-fuel capability means that these engines do not require a specific high-octane gasoline but can operate with a wide range of fuels. Low emissions of pollutants is possible because the engines operate at lower peak temperatures than the spark- ignition engine, require a leaner fuel-air mixture, and are continuous combustion devices. Which engine will prove most suitable for possible introduction by automobile companies in the future remains to be determined.

A.) GAS TURBINES: The objective of the Gas Turbine Project is to demonstrate an experimental propulsion system by 1984 that has at least a 30-percent improvement in fuel economy over that presently predicted for a 1984 conventional spark-ignition powertrain system. Also, the system must have the ability to use a variety of fuels and have emission levels less than the Federal Standards/Research Objectives. Achievement of this overall objective with the attendant requirements of cost competitiveness will provide the automobile manufacturers with a production option.

The government's automotive gas turbine program began in the early 1970's under Environmental Protection Agency management. The objective at that time was to demonstrate low emissions using a Chrysler 150 hp gas turbine as a baseline engine. In 1973, attention focused on improved fuel economy through development of a 100 hp Upgraded engine. The engine, first tested in July 1976, fell short of the program goals. In October 1976, Lewis assumed management of the gas turbine project for DOE (then ERDA) and a corrective action program for the Upgraded engine was initiated. Also, late in 1976 a program to advance the state-of-the-art through the use of ceramic components was initiated with Detroit-Diesel Allison. An existing DDA heavy Duty gas turbine engine was used as a test bed for that effort.

With the enactment of the Automotive Propulsion Research and Development Act of 1977 (PL 95-238) the program has been accelerated.

In March 1979 the Upgraded engine corrective action program was completed at Chrysler. Engine power has been increased to 90 hp (90% of original goal), but problems remain with durability of the gas bearing, performance deficiencies in the regenerator, the turbine interstage duct and the combustor (emission levels). A small effort at Lewis will continue in an attempt to correct those problems and gain further in-house hand-on experience. However, the bulk of the gas turbine project is being conducted through government R&D contracts in order to ensure the technology resides in industry where it must be used and marketed.

At present, efforts focus on the development of an Advanced Gas Turbine experimental engine capable of demonstrating the technical goals. Technology efforts in support of the Advanced Gas Turbine are underway in bearings, component aerodynamics, heat exchangers, high temperature materials and combustors. As used herein, an experimental engine is one which is developed and tested in the proof-of-concept technology development phase. It is not expected to either be producible at low cost or to be marketable. That is the job of industry.

A key to the successful experimental engine is the use of ceramic components. Present all-metal gas turbines operate at turbine inlet temperatures of 1835°F. To meet the 1984 goal it is predicted that this temperature must be increased to about 2265°F (still well below peak temperatures encountered in a spark-ignition engine). Thus, efforts are directed at a gradual introduction of ceramic components into the engine. (Ceramics are capable of withstanding much higher temperatures than metals.) Toward this end, under a 6½ year contract with DDA, ceramic components are being developed and tested in an existing industrial gas turbine engine. To date, ceramic regenerators and ceramic gasifier turbine tip shrouds and nozzle vanes have been successfully operated in an engine at a turbine inlet temperature of 1900°F (65°F above the all-metal engine temperatures). The Japanese government has committed

$60 million to research on ceramics stimulated by Lewis Research Center. There currently is no money committed by the United States in this area.

B.) STIRLING ENGINES: The objective of the Stirling Engine Project is to demonstrate an experimental propulsion system by 1984 that has at least 30 percent improvement in fuel economy over that presently predicted for a 1984 conventional spark-ignition powertrain system with the same fuel. In addition, the system must be able to use a broad range of fuels including coal-derived or shale-derived synthetics and meet the emission levels of the Federal Standards/Research Objectives. Achievement of this overall objective with the attendant requirements of cost competitiveness will provide the automobile manufacturers with a production option. In other words, the objective of the Stirling Engine Project is virtually the same as that of the Gas Turbine Project.

Recall that earlier it was mentioned that the Gas Turbine and the Stirling Engine were selected as two promising concepts as a alternative to the spark-ignition engine after detailed analysis and exploratory research on a number of alternatives. At this point in time, which of these two approaches has a better chance of success is not clear. Consequently, the projects have similar overall objectives within the same time frame, but are structured so as to permit a selection of one or the other at appropriate decision points in the schedules should it become evident that one has a significant advantage over the other.

Stirling engine technology has been under development for a variety of nonautomotive applications for about forty years by the N.V. Philips Company of the Netherlands, and more recently, the United Stirling Company of Sweden. In 1971, the Ford Motor Company initiated a joint program with Philips to investigate a Stirling engine for automotive application. The program resulted in a Ford/Philips 4-215 experimental engine. In 1977, Lewis accepted project management responsibility for the DOE Stirling Engine Program. Under contract, the Ford Motor Company conducted an assessment of the fuel economy potential of the Stirling Engine using the Ford/Philips 4-215 engine as a data base.

It was predicted that a 40-80 percent improvement in fuel economy over the spark-ignition engine was feasible with further development. Because of a need to devote their resources to pressing near-term problems however, Ford terminated their Stirling engine activities.

Today, the primary engine development effort is being conducted on contract by a team consisting of Mechanical Technologies, Inc., United Stirling of Sweden and American Motors General.

The Stirling engine is a continuous combustion engine which utilizes an external heat source (in contrast to an internal combustion engine). Heat is transferred to a contained working fluid (usually hydrogen) through a metallic wall. The working fluid cycles back and forth driving pistons up and down and generating propulsive power. A regenerator located inside the engine stores heat and later returns it to the working fluid resulting in improved fuel economy.

Although invented more than a century ago and used in certain stationary power applications (e.g., driving pumps in mines) little consideration was given to Stirling engine application for propulsion. This was largely because of problems of weight and size and, heretofore, the availability of inexpensive gasoline for use in the internal combustion spark ignition engine. Today, however, circumstances are quite different.

Efforts now are directed toward reducing engine size and weight, improving component performance and durability, and development of materials to better contain the working fluid. Both dynamometer testing and in-vehicle testing are being conducted using the United Stirling P-40 as a baseline engine. Design of an experimental automobile Stirling engine is underway.

VEHICLE SYSTEM

The objective of the Vehicle Systems Project which is being conducted by Lewis for DOE is to aid the industry in the acceleration of the commercialization of alternative heat engines and certain powertrain technology.

Thus, this project is another facet of the overall DOE program in transportation energy conservation.

Activities in the Vehicle Systems Project range from demonstrating the use of gas turbine engines in buses both within the city and on the highway, to demonstrating the use of a Controlled Speed Accessory Drive (CSAD) in a fleet of 400 government owned automobiles all for the purpose of identifying technical problems requiring further research. Other technology demonstrations underway include an organic Rankine cycle bottomed diesel truck engine and a turbocompound truck engine. Both of these concepts are aimed at improving the performance of diesel truck engine systems. Transmission technology efforts are underway to develop a traction type transmission suitable for use with gas turbine powered propulsion systems.

Major contractors in this project include Greyhound Lines, Inc., Baltimore MTA, Booz-Allen and Hamilton, Detroit Diesel Allison, Thermo-Electron Corp., Cummings Engine Co., and Transmission Research, Inc.

A.) DIESEL EMISSIONS CONTROL TECHNOLOGY: In connection with diesel engines, a small activity in diesel emissions control technology was recently initiated for DOE. The objective is to assess control technology for the control of particulate and other emissions from diesel engines that are designed for use in automobiles and light duty trucks primarily by conducting test, evaluation and experimental activities to accumulate data.

B.) ELECTRIC (AND HYBRID) VEHICLE PROPULSION SYSTEMS R&T PROJECT: The DOE is conducting a program in Electric and Hybrid Vehicles aimed at reducing the nation's dependence on petroleum through the development of automobiles which use electricity as a primary source of power. The program was authorized by Congress under Public Law 94-312, the Electric and Hybrid Vehicle (E&HV) Research, Development and Demonstration Act of 1976. Three organizations are implementing the program for DOE. Battery development for electric vehicles is being conducted by Argonne National Laboratory. Vehicle systems R&D is being managed by the Jet Propulsion Laboratory, and propulsion systems R&D is being managed by the Lewis Research Center.

The Electric and Hybrid Vehicle Research, Development and Demonstration Act of 1976 required (under Section 7) that data characterizing the present state-of-the-art of electric and hybrid vehicles be developed and reported to Congress. The results of an extensive state-of-the-art survey conducted by Lewis for DOE (then ERDA) were reported in September 1977. It was found that a substantial number of electric vehicles have been buily by converting conventional heat engine vehicles to electric vehicles. The electric vehicle industry in the United States is not a mature industry. Components used in electric vehicles usually were designed or built for other purposes, consequently, it was not surprising that all vehicles had limited range, acceleration, maximum speed and hill climbing ability; and, it was equally clear that a focused research and technology program could produce substantial improvements in electric vehicle performance and hence an expended potential for use. Hybrid vehicles, in which a heat engine is used in combination with electric propulsion, principally to increase range, were found to number far fewer and subject to similar technical constraints.

Technical challenges are being addressed today primarily by means of R&D contracts. These include motor, controller and transmission characterization and battery propulsion system interaction studies. Tractor motor and motor controller development for both ac and dc systems is underway, focusing both on components designed for near term service and new technologies and design approaches for advanced systems.

NASA's ability to foster new technology and assure its usefulness to the American public, and its incorporation by American industry, has been proven time and time again.

NASA, and Lewis Research Center in particular, has people with critical job skills and professional expertise in most, if not all, of the key areas that national research and development programs require.

The U.S. automobile industry is in a particularly vulnerable position at the present time.

.. Needed new technology is not being developed fast enough to keep U.S. automobiles competitive in U.S. markets, let alone world markets.

.. The Japanese automobile industry is likely to produce more cars than the U.S. in 1982.

.. Soaring fuel costs and rates of inflation have depressed consumer demand for U.S. - produced automobiles.

.. Financial and technical manpower resources of U.S. companies are at their limits just dealing with short-term problems (e.g., Ford Motor Company's inability to continue research on the Stirling Engine, in spite of its obvious promise)

The last few pages of detailed comments have pointed out NASA's involvement and particularly Lewis's expertise in these areas. Similar detailed comments and information could be provided in all of the areas under attack, particularly aeronautics and communication. As part of the impact on the state of Ohio and the Cleveland area, we have included an Appendix (Impact on Ohio and Cleveland) to cover these issues.

In conclusion, we would like to make some general remarks. Acceptance of the NASA budget cuts currently being considered by the Reagan Administration and OMB would fundamentally change the nature and character of our Space Agency. They would require termination of our aeronautics, space application and planetary exploration programs. They would force the agency to lay off thousands of employees.

The contemplated budget reductions simply cannot be accepted. Although they would produce some budgetary savings in the short-run, over the long term they would knock our Nation out of its leadership position in space. We cannot afford this either economically or militarily.

The justification for our space program lies in the benefits it produces for us in the here and now, benefits that enhance the lives of each and every one of us. Consider the following:

> Countless thousands of human lives and millions of dollars have been saved through satellite warnings of hurricanes, typhoons, and severe storms.
>
> Advanced weather forecasts have increased crops yields all around the globe.
>
> Communications satellites are bringing us all closer together, linking continents at half the cost of just ten years ago.
>
> Aircraft, automobiles, ships, and buildings are now more structurally sound, safer, and more economically constructed thanks to structural analysis techniques developed by NASA.
>
> Our country as a whole is more secure because observation, reconnaissance and early warning satellites have made a surprise attack on the United States less feasible, and therefore less likely.
>
> Experts estimate that the cost/benefit, return on investment ratio for the space program may be-as high as 8-to-1.

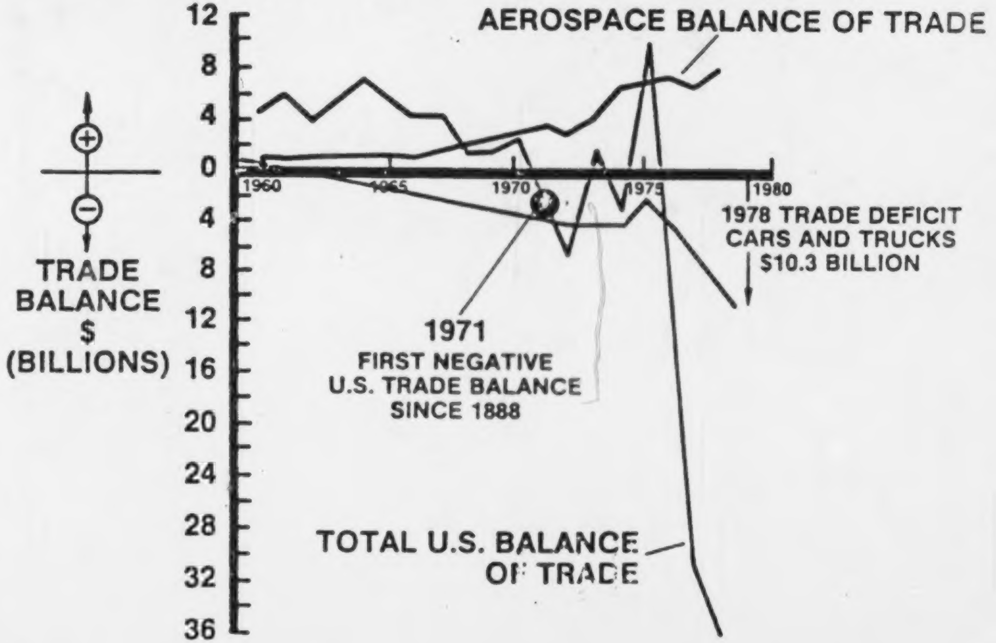
Basic research represents nothing less than the key to our future. In today's world, our economic and military strength depend upon boosting our efforts in this area. Failing to meet this challenge is the surest way to forfeit our claim to world leadership. It's just that simple.

FIGURE 1

Lewis Research Center

NASA

AEROSPACE & THE U.S. BALANCE OF TRADE (Domestic Exports minus Imports)



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APPENDIX I IMPACT ON OHIO AND CLEVELAND

The state of Ohio currently has 11.4% unemployment, 3% above the National average. The Cleveland area is heavily dependent on the automotive industry which has suffered severe cutbacks. Cleveland is currently trying to rebuild; attacking Lewis could be a fatal blow.

1. NASA Lewis budget is about $500,000,000.
2. $80,000,000 is the current payroll for government and contractor employees; $125,000,000 is the amount spent in the Cleveland area.
3. Millions are spent for small machine shops, tools, painters, carpenters, electronic components and repair, etc.
4. According to Growth Association statistics, every 42 Federal jobs has a total impact of 153 jobs in the area, a 3.64 impact. For the 2690 civil service employees this represents 9800 jobs in the greater Cleveland area. This doesn't include contractor personnel which numbers 500.
5. Lewis employees represent a large fraction of the evening faculty in Engineering, Physics, and Math at local colleges and universities.
6. Lewis Research Center is the only governmental high research center in Ohio. (Wright-Patterson AFB has almost totally stopped basic research since the demise of Aeronautical Research Laboratories.)
7. Lewis is the nucleus for a consortium of universities (CWRU,CSU, Toledo U., Akron U.) which should result in the growth of high technology in Cleveland and Northeast Ohio. This would serve as a device for attracting growth industries into Cleveland and generate ideas which could result in new starts, an area which should be of interest to Reagonomics.

APPENDIX I continued
Page 2

8. Lewis has a cooperative program with the Cleveland Public Schools inner city students where 60 of them are provided basic training which will make them more employable in the future. Lewis employees make up the majority of the volunteer tutors in the Cleveland Public Schools (volunteers in progress programs which services about 100 inner city children).

9. The Lewis employees are highly educated, dedicated individuals that participate in many of the area's civic and public service activities.

10. Extensive cancer, heart and medical technology research programs in conjuction with the Cleveland Clinic are in effect.

Andrew J. Benek Jr.
Andrew J. Benek, Jr.
President
AFGE, Local 2182

Ex V.P. For
Coulson Scheuermann
President
IFPTE, Local 28

Air Transport Association ata OF AMERICA

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Phone (202) 626-4021

John E. Ralph
Senior Vice President
Operations and Airports

December 22, 1981

The Honorable Dan Glickman
Chairman
Subcommittee on Transportation, Aviation
and Materials
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C. 20515

Dear Representative Glickman:

Recently your Subcommittee on Transportation, Aviation and Materials held hearings on "The First 'A' in NASA." As you know, the Air Transport Association has a continuing long-term interest in NASA's aeronautical programs. It would be appreciated if the attached written statement were included in the hearing record.

We will be carefully reviewing the NASA aeronautics program associated with the Administration's FY-1983 budget when it is finalized, and expect to have additional views at that time.

If we can be of assistance in this matter, please let me know.

Sincerely,

John E. Ralph

John E. Ralph

Attachment

Statement of the
Air Transport Association of America
Submitted to the Subcommittee on Transportation, Aviation and Materials
Committee on Science and Technology
House of Representatives
December 22, 1981

The Air Transport Association of America (ATA), which represents virtually all of the U. S. scheduled air carriers, requests that this statement be included in the Subcommittee hearing record. In view of the Chairman's letter to several airlines inviting written statements regarding their views, some may submit additional comments to the Subcommittee on this matter. In any case, we appreciate the opportunity, on behalf of our member carriers, to submit updated views on the role of the National Aeronautics and Space Administration (NASA) in conducting aeronautical research. While extending application to future years, these views are consistent with March 17, 1981 and March 27, 1981 submissions to the Subcommittee, as well as a September 3, 1981 letter from John E. Ralph, Senior Vice President - Operations and Airports, Air Transport Association, to the Chairman of the Committee on Science and Technology. It may also be appropriate for these earlier statements to be included in the record of the recent hearings on NASA's Aeronautical Research and Technology program.

The scheduled airlines depend heavily on NASA for much of the research work necessary to improve safety and efficiency of airline operations, particularly for technological advances permitting basic improvements to engines and airframes, and in human engineering. There are, of course, areas of common interest in research conducted by FAA, and there have been numerous cooperative efforts involving both organizations. The NASA work has, in the past, performed the important role of increasing the state-of-the-art in a number of needed technologies, permitting commercialization by manufacturers and airlines in a way which has contributed to the safety and economic viability of the U. S. aviation industry.

Scheduled air transportation is indebted to NASA's predecessor, the National Advisory Committee on Aeronautics (NACA) which was a major force in shaping air transportation technology before the 1960's. In the early 1970's NASA revitalized the ongoing work on aeronautics. Significant results include the NASA human factors efforts. In particular, the work on flight crew resource management has become the basis of many airline flight training programs providing improved capability to cope with unusual flight situations. In addition, the NASA work on composite structures and high bypass engines served as a catalyst to the industry's development of more efficient transport aircraft.

While the aircraft and engine manufacturers are the direct beneficiaries of NASA's Aeronautical Research and Technology program on airframes and engines, the resulting improved and more efficient aircraft lead to a stronger airline industry. The continuing viability of this industry provides benefits to the nation through a better transportation system. In addition, benefits accrue from being able to purchase aircraft in a competitive marketplace, the existence of which is fostered by the availability of the technological improvements nurtured at NASA. In a number of cases, such as with the resource management work mentioned above, the benefits of NASA aeronautical research also flow directly to the airlines.

In principle, we agree that the NASA Aeronautical Research and Technology budget is capital investment in the long-term health of the nation's air transportation system, and the nation as a whole. Thus, this work is for the benefit of all. The need to efficiently reduce government spending in order to provide a basis for an improved economy is a national goal worthy of support. However, major budget reductions should not be made in fundamental research which will permit the return to a healthy economy. ATA is concerned that the suggested cuts in the NASA aeronautical program would have adverse long-term effects, eroding the potential of the airlines to maintain economic viability in the years ahead.

We believe the NASA programs on fuel efficiency should be aggressively pursued, including the development of the advanced turboprop, the large composite primary aircraft structures (LCPAS) program, and the energy efficient engine (E^3) program. The critical aircraft resources technology program and the work on active controls also hold promise for more efficient aircraft, and should be continued. In addition, we believe NASA's superior capability in human factors engineering should continue to address areas of potential operating safety improvements. We also believe that the proposed numerical aerodynamic simulator (NAS) should be established utilizing multi-year funding.

NASA should continue its efforts regarding noise. In addition, we believe the earlier NASA wake vortex alleviation efforts should be followed up by a vigorous technology program aimed at practical reduction of the vortex at the aircraft. Today, these vortices cause a major capacity/delay restriction in our nation's air transportation system resulting in a significant waste of resources.

We do not believe that this fundamental work will be accomplished in a timely way if the NASA aeronautical research budget is reduced. Further, while some have suggested that the Department of Defense conduct additional aeronautical research in lieu of NASA, it is questionable whether DOD would even be able to pick up its own needs, let alone the aeronautical research work for civil aeronautics. It is also questionable whether industry would be able to fund this aeronautical research work.

In addition, we think that this type of research work requires continuity and takes teams of highly skilled professional people. In our view, NASA's aeronautical efforts are already understaffed -- further cuts would likely kill the important team capability. To reestablish the team will likely take several years. Rather than future rebuilding, we believe NASA's aeronautical teams should be held together at this time, and strengthened rather than weakened.

Accordingly, in order to accomplish the needed research and to maintain the NASA teams, we recommend that NASA be funded for a vigorous aeronautical research program, at a level no less than the FY-1980 budget. Such a program is, in our view, essential to the long-term health of the air transportation system and the United States.

50th Anniversary Celebration

American Institute of Aeronautics and Astronautics
1290 Avenue of the Americas, New York, N.Y. 10104
Telephone 212/581-4300

December 15, 1981

Honorable Dan Glickman, Chairman
Subcommittee on Transportation, Aviation, and Materials
Committee of Science and Technology
U.S. House of Representatives
Suite 2321 - Rayburn House Office Building
Washington, DC 20515

Dear Mr. Glickman:

I am pleased to accept your invitation to respond briefly to the various issues surrounding NASA's aeronautics program, which you enumerated in your letter of December 1.

My comments are expressed on behalf of the American Institute of Aeronautics & Astronautics, which represents a wide cross section of the technical manpower residing in the U.S. aviation industry.

We have very strong convictions about the beneficial relationship between NASA and the aviation industry, and strongly advocate that this relationship be perpetuated undiminished. This, of course, requires that the NASA aeronautics program be preserved.

We believe we can offer cogent and factual reasons for our position,and to this end I have summarized salient comments to the general issues raised in your letter with respect to the First "A" in NASA:

QUESTION:

1. From the historical perspective, how has NACA/NASA contributed to our national security and economic well being? (Examples of NACA/NASA contributions to progress in both civil and military aircraft would be useful.)

ANSWER:

NACA/NASA has made significant technical contributions to the development of both civil and military aircraft. In a general sense, it has filled the role of a "consulting" agency to both industry and the military services, providing invaluable assistance over the years on a variety of technological problems. This assistance includes the use by industry of NASA's unique group of wind tunnels and other facilities, as well as basic research support.

NASA has also made many specific technical contributions to the nation:

- o The NACA series of airfoils of the 1930's, which formed the basis for current conventional wing designs;

- "Area-Ruled" fuselage configurations;
- Noise reduction of propulsion systems;
- Efficient transonic wing designs as a consequence of supercritical airfoils, for both commercial and military aircraft;
- Research in composite materials, fuel-efficient engines and propellers, crashworthiness, and new energy devices;
- Development of technology demonstrator aircraft;
- Use of remotely-piloted vehicles for aircraft stall and spin research.

QUESTION:

2. Current benefits of a strong aeronautical industry. Relationship of NASA-sponsored aeronautical research and technology development to those benefits.

ANSWER:

There should be no doubt about the need for a strong aeronautical industry. The continued growth of our airline industry and the technical development support to the military services critically depend on the lasting strength of our aviation industry. NASA's aeronautical R&T activities play a major role in this setting. They provide a "focus" for the advancement of the state-of-the-art, in order to guide our long term research along pre-planned paths to meet the aeronautical needs of the nation. In addition to NASA's basic theoretical research and its extensive technical report dissemination system, the availability of NASA's ground and flight test facilities are highly important resources available to industry. As an example, during the development of the F-14 Navy fighter aircraft, at least thirteen different NASA wind tunnel facilities were used over a two-year period, during which over 3,000 hours of testing was accumulated (18% of the total program testing.) Many of NASA's facilities are unique and cannot be duplicated by industry; such as the new National Transonic Facility (a cryogenic wind tunnel) at NASA/Langley; the 40 ft. x 80 ft. full scale tunnel at AMES; and the differential maneuvering simulator at Langley. Curtailment or shutdown of such facilities would deal a serious blow to the U.S. aeronautical industry.

QUESTION:

3. Foreign technological efforts (programs/resources/facilities) devoted to overtake the U.S. lead.

ANSWER:

Foreign technological efforts have a definite and strong potential to overtake the U.S. aeronautical lead, if we allow our own R&T program to be weakened. We believe our current lead is marginal, while the competition from European countries and the U.S.S.R. is keen. Moreover, their products are, by and large, of excellent quality, as, for example, the European Airbus, which provided the first serious competition to U.S. commercial jet transports.

QUESTION:

4. Does industry need the contribution of NASA or could industry do its own R&T? Are the economic incentives great enough to induce industry to make the necessary investments? Could the U.S. compete successfully if federally-sponsored R&T were curtailed?

ANSWER:

Industry could not assume the aeronautical R&T now performed by NASA. There are a number of reasons for this contention:

a. If industry were forced to conduct its own R&T, gross inefficiencies would result since each company would obviously tailor its R&T program to maximize its own particular profit objectives. This could lead to duplication as well as the overlooking of some basic aeronautical requirements. The ordered advancement of the state-of-the-art now practiced by NASA would disappear and its traditional research "independence" would be abolished. Such a situation, if allowed to develop, would result in wasteful duplication of effort, since various companies would surely pursue similar or identical research objectives, and guard these jealously from the competition. In this process, significant areas of technical development may also be neglected. The central role of NASA as an unbiased "dispenser" of technology available to the entire industry would be eliminated.

b. It is unlikely that industry could alone bear the cost of the R&T to maintain the required pace for the advancement of aeronautical technology. Thus, an unacceptable slow down in U.S. aeronautical technology development would ensue.

c. Industry could not undertake the required long term, sustained research which often contains significant development risks. Doing this would quickly lead to a dilution of resources and a dissipation of profit margins.

   Yet, risk must be incurred when advancing the frontiers of technology. Only government can accomplish this successfully.

d. Industry could not duplicate the often irreplaceable human technical skills currently present in NASA's aeronautical R&T team. In a NASA budget curtailment, these people would become ineffective and their expertise would erode.

QUESTION:

5. Is an independent NASA important to the military? What role does NASA play in the development of military aircraft?

ANSWER:

NASA is definitely important to the military. It complements the services' work by "auditing" new military aircraft designs as an independent technical government agency. In fact, the services frequently seek the advice, consultation, and support of NASA in the development of military aeronautical hardware. (Examples are improvements of operational effectiveness of F-14 and F-16 aircraft.)

NASA supports the military with their wind tunnels, simulation facilities, and laboratory facilities. In the tactical aircraft field, NASA's current contribution is marginal (because of current budget constraints), but there are notable contributions nevertheless - aircraft stall and spin studies, strake wing and vortex lift studies which have improved the performance of tactical aircraft. In the area of military transports, NASA's contributions have been quite significant, largely because of commonalities with commercial transport developments, which NASA has contributed to for many years.

QUESTION:

6. Should NASA continue in both research and technology development? To what extent does technology transfer, to useful products, depend on government involvement in both kinds of activity?

ANSWER:

NASA should continue in both research and technology development. Both elements must interact closely if a technology transfer to useful products is to result.

NASA has made notable contributions in this regard. We can cite again the supersonic "area-rule" to shape the aircraft fuselage; the expanding utilization of composite materials in both commercial and military aircraft; the development of microwave landing systems to improve air traffic over high density airports; finally, the development of efficient advanced transonic wing designs for both commercial and military aircraft.

These examples vividly illustrate the role of NASA as an innovator in basic research and the subsequent application of such concepts by the civil and military user community. This interaction is crucial and must be continued.

QUESTION:

7. Should NASA continue in all of the primary research areas in which it is presently engaged? What might be the consequences of a NASA withdrawal from propulsion?

ANSWER:

NASA should continue in all of its present primary research areas. The reasons for this have been amply discussed in the previous paragraphs.

NASA's withdrawal from the field of propulsion is not advocated, since it conducts many highly important programs in that field. These include fuel efficient aircraft and propeller designs; noise reduction studies; the newly emerging technology of integrating flight controls with propulsion controls, to improve system effectiveness and to reduce pilot work load.

These activities are vital to the airline industry as well as to the U.S. military services.

I trust that our observations will prove helpful in your committee discussions. Please feel free to contact me if you require any additional information or clarification.

Very truly yours,

Joseph G. Gavin, Jr.
President, AIAA

Beech Aircraft Corporation
Wichita, Kansas 67201
U. S. A.

December 15, 1981

Honorable Dan Glickman
House of Representatives
Washington, DC 20515

Dear Dan:

Thank you for your invitation to Mrs. Beech to submit testimony to the Subcommittee on Transportation, Aviation and Materials on the first "A" in NASA. Mrs. Beech has asked me to reply to your letter.

The question posed in your letter deals with the fundamental value of investment by the Federal Government into research and technological advancement. Undoubtedly, while there are economies which can be achieved in the NASA aeronautics budget, we would view a drastic curtailment with considerable concern. The NACA and its successor, NASA, have been one of the primary sources of effective technology in the United States since the very early days of aviation. The synergistic partnership between NACA/NASA, the military services and the aviation industry has been a unique and winning combination. In our view, the effectiveness of this partnership is directly responsible for the pre-eminence of the United States in aeronautics.

NASA's role in this partnership is particularly important by providing a long range view in high risk technology areas and the necessary facilities and trained research staff. No single industrial organization could afford the costs involved in assuming that role.

Because of the increased competition from abroad, we would strongly urge that the effectiveness of this combination be strengthened with increased research efforts instead of a drastic curtailment. We continue to believe that this can be achieved without major increases in budget by careful definition and application of objectives to eliminate duplication.

This position is consistent with the views expressed to Senator Cannon earlier this year in response to his questions on NASA aeronautics. The correspondence with Senator Cannon is enclosed for your reference.

The importance of NASA's role in aeronautics was considered in some detail at the workshop in 1980 at the National Academy of Sciences Study Center, Woods Hole, Massachusetts. This workshop involved a broad cross-section of leaders from industry, government and academia. The deliberation of this workshop and its recommendations dealt in considerable depth many of the questions posed in your letter, and we would refer you to that study. I have enclosed a copy of the summary volume produced by that workshop.

In particular, I would like to emphasize one of the overriding messages from the workshop taken from the chairman, Mr. H. Guyford Stever, in his report transmittal letter,

> "Finally, because of the economic, social, political and technological challenges perceived to be currently threatening the U. S. leadership in aeronautics, the aviation community represented at the ASEB Workshop concluded that there is an urgent need for a clear and emphatic statement to reaffirm, clarify and strengthen NASA's role in aeronautics. This is important to enable NASA to fully and successfully sustain its mission as mandated by the National Aeronautics and Space Act of 1958. Indeed, such a statement should be part of a broad commitment to a strong national policy for aeronautics."

Sincerely,

BEECH AIRCRAFT CORPORATION

C. A. Rembleske
Senior Vice President
Engineering

Enclosures: 2

CAR:blm

Beech Aircraft Corporation
Wichita, Kansas 67201
U.S.A.

CHESTER A. REMBLESKE
VICE PRESIDENT
ENGINEERING

February 13, 1981

The Honorable Howard W. Cannon
United States Senate
Committee on Commerce, Science,
and Transportation
Washington, D.C. 20510

Dear Senator Cannon:

Thank you for your letter of January 8, 1981, requesting views and comments on industry needs for aeronautical research and technology development. As our industry progresses, both domesticly and overseas, the need for technology advancement in several areas has become readily apparent.

The deregulation of our airlines makes apparent the need for expanded capability of general aviation type aircraft to replace the services that are being discontinued by commercial air carriers. The movement of many industrial organizations out of the large metropolitan areas further emphasizes the need for transportation facilities other than certified air carriers.

Our industry has in the past depended upon export customers to the extent of approximately 25% to 35% of our output. In recent years there have been two significant facets which will no doubt bear considerably on the future use of U.S. developed aircraft outside of our continental confines. The first is the shortage and in some places absolute unavailability of aviation gasoline. The second is the severe tightening of noise emissions of aircraft. Another factor which will have a bearing on our aircraft development in the near future is our own need to conserve energy regardless of the form it takes.

With the above precepts in mind, there are certain activities which I feel our Government should consider including in its research activities through NASA. Among the programs which should be considered are the following:

1. Development of low-cost turbine technology in the low thrust area.
2. The development of needed technology to permit operation of current technology engines, with slight modifications, to use other than aviation gasoline as a fuel.

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3. The development of high speed propeller technology which would permit the manufacture of high performance propellers for use with economic fuel power plants, such as turboprops (up to 1500 shp).

4. Development of structural information including manufacturing technology which would lead to use of composites in our industry other than the current high priced carbon and boron fibers (Kevlar).

5. Development of technology which would enhance the capabilities of aircraft to fly more safely in an IFR-icing environment.

6. Technological advancements need to be made in the low-speed flight characteristics of conventional aircraft especially as they relate to the stall-incipient spin, mode of flight.

7. The need exists for efforts to reduce external, as well as internal, noise levels in our aircraft. Technology associated with external noise needs to be developed with the objective of significant reductions in today's noise levels.

8. Investigations in human factors effects on pilot actions leading to reduction of accidents caused by unexplanable pilot actions, such as certain IFR cruise and approach incidents.

While some of the above programs have had some degree of funding and activity in the past, none of these areas are being pursued rapidly enough to permit benefits to accrue to our national interest in a reasonable length of time. It is felt that proper coordination of Government research efforts with the needs of industry, to prioritize the needed technology elements with available funding, would lead to the expenditure of funding consistent with industry needs.

You are no doubt well aware that export sales at the present time for general aviation aircraft are approximately $600 million, or approximately 27% of our current domestic production. Loss of a dominant share of this market is at stake and/or in danger of being lost if we do not provide vehicles consistent with the needs and governmental regulations of importing countries.

The 1981 NASA budget is $5.76 billion, of which $264 million is slated for aeronautics research and technology. Of that $264 million, $10 million was earmarked for general aviation projects which is less than 2% of the total NASA budget. Detailed estimates to determine the magnitude of necessary funding would require close evaluation by those performing such research; but it is felt that raising general aviation's portion to approximately 4% would assist greatly in most of the above programs.

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Relative to your discussion on cost sharing, it is felt that some of the monies to permit raising of this budget could come from elimination of the duplication of research efforts, research facilities and research personnel within the FAA. I feel that NASA should be our industry's research base for all activities relating to the aircraft technology, with the possible exclusion of those areas relating to air traffic control and its related sciences.

I further feel that no money should be spent towards the development by NASA on actual hardware. That is, no hardware implementation monies should be allocated. The industry is capable of conducting the necessary development for the incorporation of technology developed by NASA into marketable vehicles.

The matter of whether or not our aviation industry is now well enough established to need help or not, is not too significant when we consider the need to improve our lot to maintain U.S. preeminence in aeronautics which is rapidly being eroded. NASA, with their excellent staffs and facilities, can play a most important role with their recognized expertise and industry approaches to some of the problems which confront us.

Increases in NASA budget and activities in the past is one of the few areas where increased Government activity demonstratedly results in stimulation of advances in industry to the benefit of our national security, our balance of trade, and the public interest. NASA, and its predecessor NACA, has played a major role in establishing U.S. dominance in aerospace technology. A stronger NASA is needed in the aviation technology field to maintain that position in the face of our current challenges.

One further consideration that should be dealt with is the availability of U.S. developed technology to competitive sources in foreign countries. We, as a nation, have always been willing and anxious to disseminate knowledge and technical expertise to foreign countries, much to the detriment of our own industry. Because of the support granted by various foreign governments to their aeronautical industries, in many cases they have implemented new technology based on our technical information, long before our own industry is able to do so. One further disadvantage which we suffer is that these foreign governments then provide financing incentives to their industries to a point beyond which we can compete.

In summary, we feel that the ideas suggested above indicate a means of providing additional funds from the NASA budget to general aviation research. This can be done without increasing the current budget by realigning our priorities to cover those areas which are in the best interest of our country. It is imperative that we be assured that we have

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the best capability possible to provide the vehicles which will be required in the future by our commuter industry, as well as the various corporate users of our type of product. Again, this can be accomplished by elimination of existing duplication of aeronautical research facilities and personnel within our Government, and the realignment of the priorities mentioned above.

While I know this letter is long, it contains many ideas. If any of the above items spark interest with you and you desire additional comments or information, please do not hesitate to contact me.

Sincerely yours,

C. A. Rembleske
Vice President - Engineering

CAR:dd

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[illegible]
ADLAI E. STEVENSON, ILL.
WENDELL H. FORD, KY.
DONALD W. RIEGLE, JR., MICH.
J. JAMES EXON, NEBR.
HOWELL HEFLIN, ALA.

[illegible]
NANCY LANDON KASSEBAUM, KANS.
LARRY PRESSLER, S. DAK.
JOHN W. WARNER, VA.

AUBREY L. SARVIS, STAFF DIRECTOR AND CHIEF COUNSEL
EDWIN K. HALL, GENERAL COUNSEL
WILLIAM M. DIEFENDERFER, MINORITY STAFF DIRECTOR

United States Senate
COMMITTEE ON COMMERCE, SCIENCE,
AND TRANSPORTATION
WASHINGTON, D.C. 20510

January 8, 1981

RECEIVED
JAN 15 1981
BEECH AIRCRAFT

Mr. Chet A. Rembleski
Vice President-Engineering
Beech Aircraft Corporation
Wichita, Kansas 67201

Dear Mr. Rembleski:

From time to time in recent years I have heard concern expressed over relative slackening in our nation's support for aeronautical research and technology development. I am undertaking an assessment of this issue and would welcome your views and recommendations. These would be valued from the perspective of the nation's and industry's needs as you see them whether or not your company would be directly affected. The specific topics on which your suggestions and comments would be most helpful are indicated below. However, any other aspects of the issues you would prefer to touch on would be equally welcome.

1. Major programs within the wide field of aeronautics research and technology development which should be initiated or accelerated.

2. The extent to which each such program, if consummated, might favorably affect balance of payments, national security, domestic employment, international competitiveness or provide any other important benefit.

3. The monetary level and time frame that might be realistic for such new or added program support.

4. The relative cost sharing, if any, between government and industry which would be appropriate for those programs.

5. Viewpoints, pro or con, on the argument that the aviation industry is now well enough established as to need little, if any, Federal support for research and technology development.

If any aspect of your comments should touch on matters proprietary to your company, or should for any other reason be kept confidential, please so indicate.

With best wishes, I am

Sincerely yours,

Howard W. Cannon
HOWARD W. CANNON
Ranking Minority Member

HWC:esb

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Beech Aircraft Corporation
Wichita, Kansas 67201
U.S.A.

CHESTER A. REMBLESKE
VICE PRESIDENT
ENGINEERING

March 27, 1981

The Honorable Howard W. Cannon
United States Senate
Committee on Commerce, Science
and Transportation
Washington, D.C. 20510

Dear Senator Cannon:

The comments made by you to the Senate and published in the Congressional Record February 17, 1981, which you forwarded with your letter of February 26, addressed to Mrs. Beech, have been reviewed.

There is no doubt that foreign competition is rapidly closing the technological advantage that the U.S. has held since the very beginning of the aviation industry. Many reasons for our decreasing technological edge have been brought forward. Some lessons should be learned and past experience heeded as we continue to push forward with new technology, regardless of the speed of such forward movement.

The availability of U.S. technology to foreign competitors without due consideration of the effects of the use of these technologies by our competitors should be considered as new technological advances are made. We, as a nation, have always been much too willing and anxious to disseminate knowledge and technical expertise to foreign countries, much to the detriment of our own industry.

Fully recognizing the need for technical advances does not, in itself, call for major appropriations of new funds. A diligent program to reestablish our research and development priorities, and an assessment of our on-going research and development programs to match these readjusted priorities with realignment of already approved funding for many of these programs, will allow for research in new areas.

Elimination of duplications that exist today in the aeronautical research and development areas in several branches of our Government would make further funds available if such research activities were concentrated under a single agency.

NASA should only be requested to undertake such activities that cannot logically be undertaken by private industry. The implementation of technological advances into marketable hardware should not be included as a part of NASA's charter.

We want to thank you for transmitting your comments to us. We will watch with interest the action taken by Congress relating to matters discussed herein.

Sincerely yours,

C. A. Rembleske
Vice President - Engineering

CAR:dd

cc: O. A. Beech

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Bell Helicopter TEXTRON

Bell Helicopter Textron
Division of Textron Inc.

Post Office Box 482
Fort Worth, Texas 76101
(817) 280-2011

December 16, 1981

Mr. Dan Glickman, Chairman
Subcommittee on Transportation,
Aviation and Materials
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Mr. Glickman,

Our Senior Vice President, Mr. Robert Lynn, asked me to respond to your letter dated December 1, 1981, concerning a written testimony for a hearing on the First "A" in NASA. I hereby submit our answer. In case there are any questions, please contact me. I will be glad to be of further assistance.

COMMENTS ON THE FIRST "A" IN NASA

General Comment: The following discussions will pertain mainly to rotary wing oriented subjects.

Question 1. From the historical perspective, how has NACA/NASA contributed to our national security and economic well being? (examples of NACA/NASA contributions to progress in both civil and military aircraft would be useful)

Comment: NACA's role in rotary wing development goes back to the days of the autogyros, followed by very active helicopter research programs when the helicopter appeared on the scene. NASA's present involvement is equally important today in pursuing technical breakthroughs for helicopters, tilt rotors and other forms of rotary wing concepts.

Important NASA's contributions can be quoted in the analyses development as well as in the experimental field. Examples:

Analyses:
- Blade element aerodynamic analysis
- Ground resonance prediction
- Transonic aerodynamics 2 and 3D, airfoils, blade tips
- Development of the NASTRAN finite element analysis now in use through all of industry.

Experimental:

- Aerodynamic and dynamic testing in wind tunnels of airfoils, model scale rotors, full scale aircraft forms an extremely important function of NASA's contribution to civil and military aircraft.
- Handling quality development using NASA's flight simulator is becoming increasingly important.
- Flight evaluation of rotary wing concepts has yielded important results. The most recent and spectacular example is NASA's involvement in the XV-15 tilt rotor development.
- Test programs to develop crashworthy fuselage structures.

Question 2. Current benefits of a strong aeronautical industry. Relationship of NASA-sponsored aeronautical research and technology development to those benefits.

Comment: The dominating position of the U.S. rotary wing industry in the world market is increasingly challenged by foreign competition. It will require a strong industry which produces technologically advanced products in order to maintain or improve its present position.

An effective NASA sponsored research and technology program will greatly help, provided that this research remains closely integrated with the needs of industry.

Question 3. Foreign technological efforts (programs/resources/facilities) devoted to overtake the U.S. lead.

Comment: Foreign technological advances are noticeable in many fields. For instance:

- Early introduction of composite materials in rotors already gave the French a temporary advance in the marketplace.

- There is the threat that France or the USSR will embark on a tilt rotor project and overtake the U.S. lead.
- We see U.S. government researchers go to Europe to do aero-acoustic rotary wing work because the U.S. does not have the proper facility for these tests.

Development of new projects in many foreign countries is subsidized by their government. Their research laboratories integrate their work to a very high degree with the needs of their industry.

It will require a coordinated NASA involvement with industry designed around maximum payoff for U.S. products to ward off foreign competition and to maintain our technical superiority.

Question 4. Does industry need the contribution of NASA or could industry do its own R&T? Are the economic incentives great enough to induce industry to make the necessary investments? Could the U.S. compete successfully if Federally sponsored R&T were curtailed?

Comment: The unique facilities of NASA (wind tunnels, simulators, etc.) cannot be operated by industry. In specific fields industry does not have the special expertise and cannot afford to do enough general research in sufficient depth without more economic incentives. Moreover, competitive considerations will prevail, and no research results will be generated for general use.

It is believed that in the long run curtailing of Federally sponsored R&T would lead to a weakening of the U.S. industrial position in the world.

Question 5. Is an independent NASA important to the military? What role does NASA play in the development of military aircraft?

Comment: There exists a close and well working relationship between the Army Research Laboratories and NASA. Many of the programs are complementary and the same NASA facilities available to industry are available to the military branches. NASA plays an important role in the development of military aircraft.

Question 6. Should NASA continue in both research and technology developments? To what extent does technology transfer, to useful products, depend on government involvement in both kinds of activity?

Comment: In the field of rotary wing there is not a very clear distinction between research and technology development. For instance, there is a great need for more NASA involvement in rotor-noise research as a result of recent FAA considerations. This research should yield at the earliest possible moment the technology for prediction and reduction of rotor generated noise. It is hoped that NASA will get heavily involved in this activity.

NASA's primary focus should, however, be on fundamental research. Technology transfer is best achieved through contracted work with industry.

Question 7. Should NASA continue in all of the primary research areas in which it is presently engaged? What might be the consequences of a NASA withdrawal from propulsion?

Comment: The answer is that NASA, if possible, should keep involved in specific areas of research where high risk-high payoff can be expected. Withdrawal from propulsion probably is not desirable provided, of course, that NASA's programs remain relevant to industry needs.

While all of the above questions indicate a desire to keep NASA strongly involved in rotary wing research and technology, a re-examination of NASA's operation may be in order. Criticism of NASA's present operation indicates a rather slow pace, not in tune with industry's needs and inadequate to counter foreign competition. An example is the operation of research and demonstrator type aircraft. This is partly due to inadequate funding of programs due to the requirements of NASA's space programs. A redistribution of funds may be the answer.

Yours truly,

J. M. Drees

Jan M. Drees
Vice President - Technology

Cessna

18 December 1981

Congressman Dan Glickman
1507 Longworth Building
Washington, D.C. 20515

Dear Dan:

In response to your 1 December letter invitation to comment on the importance of the first "A" in NASA, I have attached some comments which I hope will be of use.

In brief summary, we believe that NASA has a necessary and vital role to play in research in aviation technology, especially airfoil development, drag reduction, engines and propellers.

The preeminence of the United States aviation industry in the world market stems in large measure from NASA's activity including work done when the agency was called NACA in the 1930's and 40's.

There are certain NASA areas of activity which are much less necessary, for example, avionics and electronics. In this latter area, the activity of related industries such as computers, instrumentation and home entertainment provide great stimulus and significant transfer.

I very much appreciate this opportunity to express our opinions. I sincerely hope that these important NASA activities will be continued.

Sincerely,

Charles B. Husick
Senior Vice President

CBH/jp
Attachment

Cessna Aircraft Company P.O. Box 1521, Wichita, Kansas 67201 316/685-9111 Telex 417-400

CESSNA'S COMMENTS

1. From the historical perspective, how has NACA/NASA contributed to our national security and economic well being? (Examples of NACA/NASA contributions to progress in both civil and military aircraft would be useful.)

Comments:

NACA thrust this nation into the forefront of aviation technology in the period just preceding World War II through pragmatic and applicable testing and development directed toward the improvement of aircraft, engines and propellers- specifically, airfoil development, drag reduction, optimization of structure, and design criteria. This activity and the several aviation advancements it spawned provided us the technology base to provide overpowering success of preservation of the Free World during World War II.

Specific studies that are contained in the war-time reports continue to be beneficial, greatly advancing the art of high altitude, air breathing propulsion and systems operation. Subsonic wind tunnel and flight research provided the basis for military subsonic flight for military aircraft as well as significant emphasis on the low speed regime of high lift devices and boundary layer control and augmentation.

High subsonic and transonic wind tunnel aerodynamic research and flight testing in the late 1940's and 1950's led to the development of commercial jet airliners and advanced military aircraft providing major industrial exports and favorable balance of payment benefits and the basis of our military contribution to national security.

With the advent of the space program in the 1960's and NASA's activities emphasizing it, we began to lose the aeronautic supremacy gained in prior years.

A notable contribution to aeronautics was Dr. Whitcomb's work in area ruling, which was applied to military as well as commercial transports in the 1960's. His more recent developments in the 1970's on supercritical airfoils have been a benefit to business and transport aircraft currently in development. This will contribute to the economic wellbeing through the export sales of United States aircraft.

2. Current benefits of a strong aeronautical industry. Relationship of NASA-sponsored aeronautical research and technology development to those benefits.

Comments

A recent obvious economic benefit of the foregoing strengthening of our industry is the purchase by Singapore of over a billion dollars worth of commercial transports as opposed to a purchase from their normal politically

2. Comments - (Continued)

tied British or possibly the Government subsidized French industry. The benefits of this infusion of money are multiplied manyfold through the numerous people in industries that supply raw material and fabricated parts for these vehicles.

Both aerodynamic research and ongoing composite material development and funded application work is of benefit to the development of fuel efficient aircraft. This is of direct benefit to the aircraft industry and all users of petro-chemical fuels in these United States.

3. Foreign technological efforts (programs/resources/facilities) devoted to overtake the U.S. lead.

Comments:

South American, Japanese, European and common market nations are pouring national resources into their aerospace industries in an effort to overtake our lead; Embreaer Air, Mitsubishi, British Aerospace, Hawker Sidley, CASA, and Dussault are but a few of the companies of "friendly" nations. In-roads are also being made by Iron Curtain countries into our marketplaces.

4. Does industry need the contribution of NASA or could industry do its own R&T. Are the economic incentives great enough to induce industry to make the necessary investments? Could the U.S. compete successfully if federally sponsored R&T were curtailed?

Comments:

Research and technology development in industry is often held as proprietary by the specific companies. Furthermore, activities are of limited extent. It is our opinion that through the limitations of industry sponsored R&T our automotive industry has not maintained world leadership. The work done by NASA in aeronautics and aircraft technology is essential to our regaining world leadership in aircraft.

Because of the time lost in aeronautical research in the 1960's and 1970's, renewed emphasis is required to reestablish the technology needed for recapturing indisputed supremacy of commercial and military aircraft.

5. Is an independent NASA important to the military? What role does NASA play in the development of military aircraft?

Comments:

As mentioned in answers to earlier issues, NASA contribution to military aircraft has been essential. Other companies would be able to supply more detailed information on this particular item.

6. Should NASA continue in both research and technology development? To what extent does technology transfer, to useful products, depend on government involvement in both kinds of activity?

Comments:

Yes, technology can only be transferred if it exists. The Government involvement in application of technology should be at the request of industry. NASA's emphasis should be on research.

Withdrawal of NASA from research and technology activity, such as the composite activity presently in process and from rotary combustion engine work would probably delay beneficial implementation 5 to 10 years.

7. Should NASA continue in all of the primary research areas in which it is presently engaged? What might be the consequences of a NASA withdrawal from propulsion?

Comments:

Continued NASA R&T in materials, low mach number propulsion, high CL development, high subsonic aerodynamics and the aerodynamic development of advanced aircraft configurations are considered important to the aviation industry. Additionally, we consider it essential that NASA continue in the development of aerodynamic, structural and aeroelastic computational capability.

Withdrawal from propulsion could lead to the foreign supremacy in both propulsion and aircraft development. This is particularly true for intermittent combustion engines and general aviation aircraft on which they are used.

NASA activities in systems areas such as avionics can be reduced or if necessary eliminated. Industry activities in research and development are sufficient, especially since there is significant transfer from related industries such as computers, telecommunications and instrumentation.

DELTA AIR LINES, INC.
HARTSFIELD ATLANTA INTERNATIONAL AIRPORT
ATLANTA, GEORGIA 30320

DAVID C. GARRETT, JR.
PRESIDENT

December 21, 1981

The Honorable Dan Glickman, Chairman
Subcommittee on Transportation,
  Aviation and Materials
U. S. House of Representatives
Suite 2321 Rayburn House Office Bldg.
Washington, D. C. 20515

Dear Mr. Glickman:

I have attached a statement expressing my views on the proposal to curtail NASA aeronautics programs.

In brief, it states that I do not favor such action and believe that NASA efforts in these fields have been worthwhile. In fact, in my opinion they need to be strengthened.

Basically, I have directed comments to your points in the listed general issues.

Very truly yours,

Attachment

STATEMENT OF DAVID C. GARRETT, JR., PRESIDENT OF DELTA AIR LINES TO THE U.S. HOUSE OF REPRESENTATIVES SUBCOMMITTEE ON TRANSPORTATION, AVIATION AND MATERIALS

COMMENTS ON THE ROLE OF NASA IN AERONAUTICAL RESEARCH

I am David C. Garrett, Jr., President and Chief Executive Officer of Delta Air Lines. Delta Air Lines serves the United States, Canada, Puerto Rico, Bahamas, Bermuda, and Europe through London and Frankfurt. Delta is a major U.S. carrier with a fleet complement of 214 aircraft and some 36,000 employees. In the near future it will have one of the most modern air transportation fleets in the world, having ordered both the B-757 and B-767 aircraft, and at present it is in the midst of negotiating for the most efficient short range aircraft that the industry is capable of producing. The size is to be 150 seats. Delta also has been one of the top leaders in developing today's fleet - the DC-9, a fine short range aircraft, the L-1011, a medium to long range aircraft - and, of course, is most active in both the B-757 and B-767 design and development programs. The overall airline aim is to influence and obtain design in the required size and range areas which will meet the needs of the air transportation industry for the next decade.

I have seen great strides in air transportation in the past twenty years. In 1960 the first DC-8 and B-707 aircraft were examples of the technology of the time. Research and applied technology brought us from the age of less-than-dependable DC-7 and Constellation types to the age of reliability and speed. Now that same continuing research has given the reliability, the dependability and the comfort which makes crossing the oceans by air a mundane, everyday event. The vast majority of long range, over ocean air transport is still U.S. design.

This plateau of reliability, dependability, size and speed has been reached, not by luck, not by chance, but by the dint of much research and scientific effort, including NASA, the FAA, the manufacturers and the airlines.

Many years ago the U.S. government undertook to form an agency where aeronautical research effort could be combined, coordinated and correlated. This was an excellent move and the efforts through the years have paid off. The U.S. has been a leader in both commercial and military aviation since the time of World War II. Foreign interests have beat a path to our door to take advantage of this expertise in aircraft design, both in the commercial and military arena. Again, this expertise was the result of a devotion of time, money and manpower to research and scientific investigation into the needs of flight science and how best to achieve these ends.

It is my understanding there is consideration being given to a diminishing role of NASA in the aeronautics field. I am firmly of the opinion that such a course should not have consideration in this day and time. It is believed that aeronautical research efforts should not be reduced, but rather increased in an attempt to have this country regain the position it once held in designing and producing the best performance and the most efficient aircraft. The whole nation needs to take a look at why we are forced to equip the Coast Guard with a foreign designed light search and patrol aircraft, why the U.S. Marines are buying and utilizing a non-U.S. design vertical takeoff fighter aircraft, a design which has never even been challenged by a U.S. counterpart, why the newly planned and selected jet trainer is to be a foreign design and why our own commercial airplane designers are finding it necessary to go to foreign lands to gain not only financial aid, but aid in technical areas as well. With such a state of affairs in our industry, is this the time to emasculate, or at best to throw into upheaval the research capacity that we have built, the facilities, the people, the programs?

Now, I am not one to be in favor of government sponsored or controlled programs. The research in aeronautics, however, I put into a different light. This highly technical, highly intricate and involved science needs a central gathering and focal point. It needs this because the country as a whole needs the benefits and it cannot be allowed to become the property of just a few. The country as a whole needs the great minds that developed our fine designs and their propulsion systems if we are to benefit not only as a country, but as a bastion of the free world as well. Let us hope that we will never be called upon again to use our scientific advancements against an enemy of this country, but if we must, then let us hope we have utilized and nurtured the scientific minds of this nation to the utmost.

Unfortunately, we have no better vehicle than NASA to achieve this end. Research into the multiple fields of aeronautics involves a building block approach where advancements are built one upon the other. No human can go back and recreate all the data and experimentation that has been collected on airfoils and their most efficient shapes, drag reduction and various flow patterns throughout a range of Mach numbers. The same is true, too, of structures and materials and life cycle and stress relationships. All of these have taken years and years to build up background and test data, and it is impossible to start fresh. These concepts, ideas and testing to meaningful conclusion is the lifeblood of our industry today, both commercial and military. Couple these basic, derived and dependent findings with work in noise sources and attendant suppression technology, CRT displays and advanced cockpits, crash research and how people can survive accidents, and you have hit on how NASA contributes to today's commercial and military aviation technologies.

In the overall aeronautical industry, it is imperative that the U.S. strengthen their hand, not weaken it. One of our major aircraft companies has just recently announced it will no longer participate in the commercial aircraft field. Another major one has indicated for its next venture, it will team up with a European manufacturer. The other major U.S. aircraft developer and builder has indicated that, for the next venture, it may wish to have a combine to include possibly the Japanese before giving a go-ahead.

These facts emphasize the appearance that here in the U.S. the aircraft industry is weak and rapidly becoming less effective. Our friends in France and Germany, however, have apparently found the answers and are taking up more and more of the commercial aircraft market, quickly stepping into the worldly gap - a gap left by the indecisive action in this country to use technology, to use research and achieve the very best in a flying machine, whether military or commercial. The French and combines of Germany have developed the research, the manufacturing, the technology and the know-how to design, build and support an airplane in just about any classification. They are prepared to step into any phase that is left open. The success of foreign competitors in both arenas is evident. This was not so ten to fifteen years ago. We have lost an edge, unfortunately, and that edge was possibly dulled when the research areas of the government made the decision to concentrate upon space much to the neglect of airplane research.

Surely, there is much yet to be done. Aerodynamic research is not finished now and I would not suppose it ever will be. Possibly, propellers again have a future in this business. We need to see how this can be done. The search for new and better materials has only started and there are vast strides to be made in lighter, more effective non-metal materials. There are better guidance systems, better instrument presentations, better fuels somewhere down the road and this work needs to be spearheaded and directed by competent, experienced people who can devote their full energies to the research task and retain the framework in a dedicated, research mode.

The question has been asked, "Can't this be done in the private sector?" Probably one of the most limiting aspects today of design and manufacture is cost. To fail to provide aid by giving all the research back to the private sector is self-defeating because it will only drive up the cost of producing and, in all probability, means the product will not be produced at all or, at best, will be mediocre in substance and performance.

I think NASA should continue and strengthen activities in aeronautical research and technical development. Propulsion systems are very much a part of the end product and should definitely be included as a definitive part of the complete system. Flow aerodynamics and materials are critical in propulsion systems and the demand for efficiency places extreme importance on this aspect of design. The jet engines of twenty years ago are mere images of the vastly improved product we have today. There is no reason to believe that tomorrow can't show still greater advancement.

I will close by saying that the research and technology development in aeronautics by NASA is badly needed by this country. Its role needs to be strengthened and emphasized. This country badly needs leadership in the commercial aircraft industry to put it once again into producing a superior product. My airline needs this and the country needs it. I would only recommend that NASA streamline itself and become more efficient to make maximum use of the funds available, to dedicate more to advancement of the state of the art and less to the internal operation. It now has the facilities and I am sure the people who have the knowledge. With proper, thorough guidance, there is no reason why this nation cannot once again reach a full position of leadership in both commercial and military aviation.

GENERAL DYNAMICS CORPORATION
Pierre Laclede Center
St. Louis, Missouri 63105

Alan M. Lovelace
Vice President Science and Engineering

314-889-8295

21 December 1981

The Honorable Dan Glickman
Chairman, Subcommittee on Transportation,
Aviation, and Materials
Committee on Science and Technology
Suite 3121, Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Chairman:

I am pleased to provide the following comments in response to your letter of 1 December 1981, regarding the role of NASA in the United States Aeronautics Program.

The long-standing NASA Aeronautics partnership with industry has contributed to the leadership role that the U.S. has enjoyed in both civil and military aviation. The fundamental nature of the NASA programs has filled a vital need in the spectrum of research and technology in aeronautics. In the absence of a vigorous NASA Aeronautics Program, the required basic science and technology of all aspects of flight would not and will not be adequately met by either other government or industry funding.

The success and importance of this partnership to the United States is easily underestimated. In part, it can be measured by the positive contributions that aeronautics products continue to make to the U.S. balance of trade. However, to sustain this position, the United States should not at this critical time reduce its activities in the face of growing and strong international competition. Without a healthy NASA aeronautics program, the U.S. industry will find itself hard-pressed to maintain its competitive research and development posture.

I hope these thoughts will be helpful to your committee's deliberations on the NASA Aeronautics Program.

Sincerely,

A. M. Lovelace

A. M. Lovelace

cc: E. J. LeFevre,
General Dynamics
Washington Office

Joint Statement by
Robert A. Richardson, Executive Director
Helicopter Association International
and
John Zugschwert, Executive Director
American Helicopter Society

Before the

Subcommittee on Transportation, Aviation and Materials
Committee on Science and Technology
U.S. House of Representatives
December 8, 1981

ROLE OF NASA IN AERONAUTICS

This statement addresses the role of NASA from the viewpoint of the United States helicopter industry and the FY82 helicopter (rotorcraft) funding support that should be extended to NASA as seen by this industry.

The Helicopter Association International (HAI), formerly called the Helicopter Association of America (HAA), and the American Helicopter Society (AHS) are independent, non-profit organizations, the combined membership of which consists of all the helicopter (rotorcraft) manufacturers of the United States as well as just about all of the operators of helicopters in this country.

Members operate in the fields of agriculture, airlines, air-taxi, construction, executive transport, law enforcement, energy exploration, rescue, logging and in many other civil applications.

During the past ten years the U.S. Civil helicopter industry growth has averaged more than 12% per year. In 1980 the industry employed over 75,000 people in manufacturing and operating. It manufactured some 1,200 helicopters, operated over 8,000 helicopters in the United States alone, and the export value of its products contributed significantly to this country's balance of trade. Gross revenue for 1980 exceeded one billion dollars. By 1990, the goal of the U.S. helicopter industry is to have 20,000 or more civil helicopters in operation, and an annual industry revenue well over three billion 1980 dollars.

Our Associations for many years have been strong supporters of NASA's rotorcraft technology development program. Several of our members have served on and continue to participate in various advisory capacities to NASA and the National Research Council as part of the National Academy of Sciences in the field of aeronautics and particularly rotorcraft R&D. Many of the technology advances of our industry that we have today are the result of previous work performed by NASA.

But more needs to be done. We are beginning to see the U.S. domestic helicopter market penetrated more and more by foreign competition, and the once very favorable U.S. balance of trade in this portion of the U.S. industrial output is diminishing. An expanded research and technology development effort is urgently needed in order that NASA can assist industry in keeping United States rotorcraft in the forefront of the world marketplace!

NASA should undertake on a high priority basis the high risk research and technology development which industry just cannot afford to do within its own resources. Such high risk R&T development many times leads to the big payoffs which can move one country or the other ahead competitively.

As an example of what has happened in the world marketplace in the past decade, in 1970 the United States produced about 70% of the free world rotorcraft dollar volume; today its share has decreased to about 50%. A projection of this trend shows that the U.S. percentage will be about 35% by the end of this decade -- 20% before the year 2000. To prevent this from happening, a dynamic NASA R&T augmentation program in coordination with industry is urgently needed. In the national interest, it must commence in earnest in FY82 and continue thereafter.

In anticipating the possibility of the United States losing a leadership role in rotorcraft, a special Task Force was created in 1978 by NASA's Office of Aeronautics and Space Technology under the auspices of the National Research Council's Aeronautics and Space Engineering Board (ASEB). The Task Force, composed of leading rotorcraft industry experts, including several members of our Associations, developed a ten year "Advanced Rotorcraft Technology Program." This program was envisaged to be a long term new initiative research effort by NASA which was to begin in FY1980. Its estimated cost over the ten-year period was about $400 million (in 1978 dollars), or at an average annual rate in the order of $40 million (see Appendix "A"). Today, however, the same program would cost in the order of $600 million at an annual average rate of some $60 million.

Unfortunately, this new initiative program for advanced rotorcraft technology development did not surface in NASA's official FY1980 budget request to Congress. Therefore, with the support of the helicopter industry through our Associations, the Congress appropriated a $5 million add-on to NASA's FY1980 budget which permitted the commencement of the advanced rotorcraft technology new initiative program, albeit on a much more modest scale than was proposed by the 1978 Task Force.

However, even that limited start on the urgently needed advanced rotorcraft technology new initiative program has not been sustained so far in the FY82 NASA budgetary process. Appendix "B" outlines our understanding of the current status of the NASA FY82 request for rotorcraft funding as part of NASA's Aeronautics budget. We consider the $38 million submittal for the NASA rotorcraft program to be woefully inadequate in the light of the national interest as outlined previously in this statement.

Therefore, in Appendix "C" we have presented the scope which our Associations, on behalf of the U.S. helicopter (rotorcraft) industry, believe the NASA rotorcraft funding program should be for FY82. This program totals $70 million, an increase of $32 million over the amount currently under consideration. This is roughly one-half of the amount industry considers is needed by NASA for "new initiatives" in FY82 as discussed earlier, reduced only because of the current policy of austere budgetary constraints of this Administration, with which this industry concurs. However, we feel that this increase is a sound investment in the national interest for the reasons outlined in this statement.

Thus, we urge that NASA's Aeronautics funding be increased by an amount sufficient to specifically earmark not less than $70 million for its FY82 rotorcraft program, consisting of $38 million for continuation of its existing program and $32 million add-on as a minimum for new initiative research efforts which should get underway in a dynamic manner in FY82.

We consider that a commitment to authorize NASA an average expenditure of some $70 to $100 million annually over the rest of this decade for the research needed for advanced rotorcraft technology development would be more than cost effective, considering the $20 billion (plus National Security) annual benefits which may be expected to result.

We will be most pleased to cooperate fully with the Subcommittee and staff in elaborating further our views on the foregoing as may be desired.

Appendix "A"

NATIONAL RESEARCH COUNCIL TASK FORCE
ADVANCED ROTORCRAFT TECHNOLOGY
PROGRAM FUNDING ESTIMATES
(In FY78 Dollars)

TOTAL PROGRAMS	$398.1
Aerodynamics and Structures	132.5
Aero/Acoustics I	26.0
II	17.5
Vibration Reduction I	20.5
II	15.0
III	15.5
Composite Airframe I	13.0
II	25.0
Flight Control and Avionic Systems	85.1
All-Weather Systems	45.0
Active Control Systems	40.1
Propulsion	104.5
Engine Component Design Methodology	54.5
Power Transfer Technology	26.0
Systems Integration I	24.0
Vehicle Configurations	76.0
High Speed I	20.5
II	25.0
Large Rotorcraft I	12.5
II	18.0

Appendix "B"

FY-1982 SCOPE OF WORK
NASA ROTORCRAFT FUNDING PROGRAM
(In $ millions)

1. Low-Speed Aircraft R&T Base		10.3
2. Low-Speed Systems Technology		27.3
Rotorcraft Operating Systems	1.4	
Advanced Rotorcraft Technology	10.8	
Advanced Rotor Systems/RSRA	6.4	
Tilt Rotor Flight Investigations	2.0	
Low-Speed Simulation and Flight Systems Support	6.7	
3. Aeronautical Systems Studies		0.4
Total		38.0

Appendix "C"

FY-1982 SCOPE OF WORK

NASA ROTORCRAFT FUNDING PROGRAM

Helicopter Association International Recommended FY 82 Budget

(Refer to Appendix "A")

(In $ millions)

1. Current NASA Programming - Proposed Funding 38.0

2. HAI Recommended Augmentations 32.0

   Note: In recognition of the need for austere budgetary control for FY82, the HAI recommendations are based on an increased R&T effort by NASA considered to be needed in the national interest to initiate the goals outlined in this testimony. Therefore, only a limited number of high priority items are included in these recommended augmentations (specific distribution of appropriated funds to be decided by NASA in coordination with industry.)

   a) Improved Rotorcraft Productivity through speed and payload increases.

   b) Reduction of Rotorcraft External and Internal noise (includes vibration reduction).

   c) Development of advanced composite materials and cost effective applications.

   d) Development of all-weather rotorcraft capability, including concept validation of Navstar GPS applications, zero-zero approach and landing technology and low/zero speed instrumentation/displays.

   e) Development of technology for operationally feasible and economically viable anti-deicing technology; also icing detection technology.

   f) Development of technology needed for fuel efficient, minimum pollution, light weight and high power propulsion systems designed to meet the special needs of advanced rotorcraft.

   g) Expansion of heavy lift helicopter (HLH) developments, taking maximum advantage of work done previously in this field.

TOTAL 70.0

FLIGHT RESEARCH LABORATORY
THE UNIVERSITY OF KANSAS CENTER FOR RESEARCH, INC.

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December 16, 1981

The Honorable Dan Glickman, Chairman
Subcommittee on Transportation, Aviation,
and Materials
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Glickman:

In response to your letter of December 1, 1981, concerning a hearing of the Subcommittee on Transportation, Aviation, and Materials, I would like to submit the following testimony for submission into the record.

The United States is the unquestioned world leader in the production and sale of commercial jet transports and general aviation aircraft. This overwhelming dominance we have enjoyed for decades did not come about by accident. It is the direct result of the foresight of the visionary leaders who established the NACA in 1915. The NACA not only built a solid base of aeronautical data for our aeronautical industry but, more importantly, pioneered breakthrough after breakthrough in aeronautical technology.

Would industry have done this work without NACA? Not likely. The NACA undertook basic research, explored unproven ideas, and built up the national research facilities that were and still are beyond the financial capability of most private firms. In the early days, they were barely able to survive, building and selling airplanes with existing technology.

Today the combined aeronautical production capability of our industry and the invaluable research capability of NASA represent a national asset whose value to our national well-being is beyond calculation. Our aeronautical industry is one of the few in the U.S. who consistently make major positive contributions to the balance of payments. Consider the fact that the sale of just one Boeing 747 offsets the sale of over 7000 foreign automobiles in the U.S. To cripple seriously the capacity of one member of this team will have a disastrous—and permanent—effect on our stature in the world of high technology aeronautical products, whether they be commercial or military.

Our leadership is now being challenged by other countries. And it is ironic that the challenge is fashioned by countries who have observed how we achieved our position, and who have the wisdom to follow that example. Not only is government support of the building of a competitive data base and research capability taking place, but also direct government subsidy of industry is providing a significant competitive edge. This challenge is to commercial transports as well as business jets. Can the smaller general aviation airplanes be far behind?

NASA's contributions to improved safety, performance, economy, and fuel efficiency continue even today. The solution of these problems represents a national challenge, beyond the capacity of any one company, especially the smaller general aviation companies who cannot begin to afford the capital investment required to provide high technology research facilities.

I cannot emphasize strongly enough, as an engineer, researcher, and educator, that NASA fulfills a vital role in the leadership and economic health of our aeronautical industry and of our transportation industry. The capability of our military aircraft is equally dependent on the contributions of NASA. Strong support for the first "A" in NASA must continue.

Sincerely,

David L. Kohlman

David L. Kohlman
Director, Flight Research Laboratory

DLK/nh

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF
AERONAUTICS AND ASTRONAUTICS
JAMES W. MAR
J.C. HUNSAKER PROFESSOR AND
DEPARTMENT HEAD

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December 24, 1981

Honorable Dan Glickman, Chairman
Subcommittee on Transportation,
Aviation, and Materials
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Congressman Glickman:

Your invitation to submit written testimony in support of the first "A" in NASA is most welcome. The strength of our country lies not only in the superiority of our military aircraft but also in dominance of our commercial aircraft. Every day in airports all over the world, U.S. built commercial aircraft are visible signs of the strength and vitality of our country. The local populace are able to see U.S. airplanes routinely taking off and landing, and this, I submit, has as important an impact on our friends as does our weapon systems.

Enclosed are my thoughts on the role played by NACA/NASA with respect to some of the general issues raised in your letter.

It is an honor and privilege to be a part of the legislative process. If you desire further information or clarification, I will be most happy to respond.

Sincerely yours,

James W. Mar

James W. Mar
Hunsaker Professor of Aerospace
Engineering, and
Department Head

JWM:hmr

Enclosure

TESTIMONY FOR THE FIRST "A" IN NASA

Prepared for the

COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON TRANSPORTATION,
AVIATION, AND MATERIALS

HONORABLE DAN GLICKMAN, CHAIRMAN

By

James W. Mar
Hunsaker Professor of Aerospace Education, and
Head of the Department of Aeronautics and Astronautics
Massachusetts Institute of Technology

1. A major strength of this country is the system of checks and balances which is the heart of our political system. In our political system we have the legislative, the executive, and judicial branches of government. This is analagous to the three legs required to support a stable platform, two legs lead to instability and four legs means that rocking of the platform is likely. This basic principle of a triad of separate but equal and mutually reinforcing organizations is an important reason why the U.S. Aeronautics is pre-eminent in the world. In Aeronautics, the triad consists of the government, the manufacturing industry, and the airline operators. Additionally, and most importantly, there is movement of people from government to industry to operator and vice versa. This mobility of people is unique to the U.S. and I believe it is one of the strengths of our country. Other nations have organizations which are counterparts to our triad but whereas our triad consists of three separate and equal legs, the triad in other nations generally have one leg which is more dominant than the others. Furthermore, in the major aeronautical nations such as the U.K., France and Germany, the Industry is nationalized and there is no longer a clear distinction between government and industry. Recent directives and legislation in this country which make it very difficult for the interchange of people amongst the three legs of the triad, in my view, are weakening the fabric of our country. It is important to the proper functioning of our society that there be a deep understanding and appreciation of the roles played by the three legs. This is best obtained by having people move from one organization to the other. Only by working in an organization over a significant time period can true understanding be gained.

2. The design, manufacture, certification and operation of an airplane requires high technology. It is not sufficient to have only the best aerodynamicists or the best riveter or the best pilots. This is akin to having the Heisman trophy running back on a football team which doesn't have an adequate front line. The creation of an outstanding airplane requires a team which has the optimum combination of aerodynamicists, structural designers, tool engineers, machinists, technicians, accountants, etc. Our Nation's domestic airline system has the world's best safety record; on a passenger mile basis, it is safer to travel on the domestic scheduled airlines than it is to ride a train or a bus. This outstanding safety record is the result of the mutual synergisms of government, industry, and operator.

3. We, the U.S., have been able to continuously modify the regulations so as to attain more and more safety. This is possible because the research base created by NASA provides the fundamental scientific and engineering understanding without which the new regulations could not be enforced by the FAA. The design of a "healthy" or "sound" airplane is relatively easily accomplished; the real challenge for the designer is to meet the specifications which postulate likely combinations of failures. For example, the fuselage in a wide bodied jet must be designed against the sudden loss of pressure which occurs due to the presence of an instantaneously created 20 square foot opening in the fuselage. The satisfaction of this specification requires more ingenuity and more sophisticated methods of analyses and tests than does the design of the "sound" fuselage. It is remarkable that the modern airplane is more efficient than past designs because if the technology for aeronautics had remained static, then the new FAA safety rules would most assuredly have resulted in less efficient airplanes. The new Boeing 757 and 767 airplanes are more efficient than the earlier airplanes because of advances in aerodynamics, structural concepts, and propulsion . . . all of these are founded upon NASA research programs.

4. The role played by NACA and NASA is a pervasive one, impacting not only airplane design but also other modes of transportation such as automobiles, trains, trucks, and ships. An airplane requires high technology and the fruits of the high technology trickle down to other societal systems. One such example of this is a very powerful computer program called NASTRAN. This was initially developed at Goddard Space Flight Center for the structural analysis of large space antennae; further development was directed by the Langley Research Center. It is now viewed as the canonical standard by the entire world of structural analysts and is being used routinely not only by aerospace firms but by other companies such as the automobile industry, the ship building industry, and consumer firms such as washing machine manufacturers. Along the way many private entrepreneurs have made considerable fortunes by providing services in the maintainance and application of NASTRAN. This example clearly demonstrates how NASA research, initially quite specifically directed toward aerospace structures, is found to be useful for civil applications and hence contributes to our national economic well being.

5. There is another example which I would like to cite to illustrate the general issues listed in the enclosure accompanying your letter. In May of 1979 a DC-10 crashed shortly after takeoff from Chicago O'Hare airport because the left engine pylon structure had failed. Immediately after the accident, inspections of the entire worldwide fleet of DC-10's revealed discrepancies which could not be easily explained and consequently the FAA Administrator suspended the type certificate of the DC-10. This action put into jeopardy not only the many airlines which operated the DC-10 aircraft but also McDonnell-Douglas, the manufacturer of the airplane. In order to re-validate the structural integrity of the wing pylon structure and in order to restore public confidence in the DC-10, the FAA Administrator directed the McDonnell-Douglas Company to conduct a DAMAGE TOLERANCE ANALYSIS of the wing pylon structure. That such an analysis could be accomplished and in a timely fashion is attributable to NACA and NASA research programs. Such an analysis was not possible during the time that McDonnell-Douglas designed the DC-10 nor was it part of the Federal Aviation Regulations at the time the DC-10 project was initiated. The foundation for the damage tolerance analysis lies in research work accomplished at the Langley Research Center in the 1950's on the effect of small cracks on the catastrophic failure of aluminum alloys and on the growth of small cracks under the kinds of cyclic loads incurred by airplanes. In those days the agency was NACA. Then in the 1960's, NASA sponsored research directed toward the structural integrity of the large pressurized tanks used to contain the liquid hydrogen and oxygen fuels used in the rocket engines of the Apollo launch vehicles. There were some spectacular failures of large tanks but from these failures NASA was able to obtain the data and to develop the methodologies for the design and fabrication of large tanks operating under pressure at cryogenic temperatures. At the end of the 1960's the U.S. Air Force was confronted with very severe structural problems in the F-111 and C-5A airplane weapon systems. It is my opinion that without the basic research on cracks and crack propagation accomplished by NACA and the pressure tank research accomplished by NASA, that these two weapon systems would not be part of the USAF inventory today. The USAF, with significant and crucial help from the experts developed under NASA programs, were able to devise structural recovery programs which kept both airplanes flying. Under the aegis of the F-111 and C-5A structural problems, a large data base was obtained along with the analytical and managerial techniques for a new approach to structural integrity which is now called DAMAGE TOLERANCE. All of this was in place and ready for exploitation by McDonnell-Douglas to demonstrate that the DC-10 wing pylon structure could meet the more stringent requirements of 1979. This was accomplished and

served as the basis for the FAA Administrator's decision to revoke the suspension of the DC-10's type certificate. The chain of accomplishments which led to the re-certification of the DC-10 airplane spans a quarter of a century. At the time the original basic work was being performed, no one could have foreseen the Apollo programs, the F-111 or C-5A airplanes or the DC-10. The researcher and his management recognized the need to understand cracks and crack propagation. I submit that without an independent organization such as the NACA/NASA, the basic research would not have been accomplished because in the 1950's airplanes were being designed with what was then considered to be adequate structural safety. Industry management would not have sponsored research on cracks because the basic philosophy of the era was that airplanes were crack-free and the design and analysis were predicted upon that belief; so why study a phenomenon which is believed not to exist! In this example, we see a chain which goes from the DC-10 to the F-111/C-5A to Apollo tanks to a research laboratory at Langley in the 1950's. The common thread is the far-sightedness and the quality of the NACA/NASA people.

6. Fundamental research is very difficult to justify by our aerospace companies because our U.S. form of capitalism places great emphasis on the bottom line; namely, profits. A separate organization such as the NASA can direct their attention to long-range goals such as more efficient engines and greater structural integrity, goals which cannot be attained in time for next year's report to the stockholders. NASA can and does pursue research which has as its objectives a greater understanding of phenomena. This desire to greater understanding can lead to better airplanes in a manner which is not always predictable. As an example of this, research at Langley into the nature of the drag rise of airfoil shapes, as the velocity of the flow approaches Mach 1, has led to a new class of airfoil shapes called the super-critical airfoil. Ostensibly this means an airplane with a supercritical airfoil shape can fly closer to the Mach 1 without experiencing an intolerable rise in the drag. However, this increase in speed is only a few percent above the speed of the airplanes represented by the present generation of wide-bodies jets, an increase which is not useful in this era of high fuel costs. The next generation of airplanes, nonetheless, will be using the new supercritical airfoil shapes, not because of their capability to fly closer to Mach 1, but because the shape of the airfoil can be exploited to yield

greater structural efficiency. Thus, basic research into the nature of drag rise of airfoil shapes has led to greater structural efficiency and, hence, to lower fuel consumption. I submit that without an independent NASA, research of this nature would not have taken place.

7. In summary, I believe that NACA/NASA contributions are important to the economic well being of our country not only because the research is applicable to the commercial airplanes but because the high technology required to create and build an efficient, useful airplane does spin-off benefits to the non-aerospace sector of our society. Additionally, NACA/NASA research is vitally important to the performance of our military weapon systems. Our country is re-examining itself and rightly so, in the light of crushing inflation and staggering interest rates. The understandable tendency to look for immediate benefits from government-sponsored programs must be tempered by a wise understanding of the strengths of our society and how these strengths are derived. I believe in the partnership of industry, government, and operator for the commercial aircraft industry. Our superiority in airplanes, our unmatched safety record, and our enviable air transportation system have evolved because there is a system of checks and balances in aerospace as there is in our political system. I urge you and your Committee members to convince the other members of Congress that a vigorous NASA is essential to the economic well being of our country.

PAN AM

C. Edward Acker
Chairman of the Board

December 17, 1981

The Honorable Dan Glickman
Chairman, Subcommittee on
Transportation, Aviation,
and Materials
Committee on Science & Technology
U. S. House of Representatives
Suite 2321 Rayburn House Office
Building
Washington, D. C. 20515

Dear Sir:

This is in reply to your letter of December 1 (received December 7) to Mr. Seawell regarding a hearing on The First "A" in NASA.

The U. S. air transport industry, even with the current economic dislocation, is still the strongest in the world, and offers lower cost and safer public trnasportation than that of almost any other country in the world (if not the safest and most economic). While the air transportation system is dependent on many factors, it is most dependent on development of high quality, efficient and safe aircraft, including propulsion and other systems, avionics, etc. The American transport airplane has reigned supreme throughout the world for almost fifty years - only recently has this supremacy been seriously challenged. Most of the larger transport airplanes operated by the airlines of the Western world are of American manufacture - an exception is the so called commuter airplane.

Development of quality transport aircraft is, of course, the primary reponsibility of the aircraft and engine manufacturing industries. The basic research to support this industry has been provided by NASA and its predecessor, NACA. We understand that, other than agricultural products, aircraft exports have represented the largest source of favorable international trade balances of the United States. Therefore we feel that NASA's Aeronautical research has been and will continue to be productive, and in the national interest.

Virtually all foreign airlines competing with those of the United States are government owned or governament sponsored and supported. The same applies to the manufacturing industry abroad. These all are supported by research establishments, which appear to be expanding, especially in France, Japan, Germany and the Netherlands. Large transport airplanes are being produced by a French-German-British-Spanish consortium, engines by the British, French and Canadians, with Japan about to enter the picture. Small transport airplanes are being produced by the British, Canadians, Dutch, Spanish, Brazilians, with Sweden and possibly Japan about to enter the picture. Meanwhile, one of the three major U. S. airframe manufacturers has announced plans to phase out of the commercial transport airplane business. There exists a distinct threat to the supremacy of the American transport airplane.

NASA's Role in Aeronautics was examined in considerable detail at a workshop sponsored by the Aeronautics and Space Engineering Board of the National Research Council at Woods Hole, Massachusetts, July 27 to August 2, 1980. Reports of this workshop were published earlier this year. In general, we support the conclusions and recommendations of this workshop, and would have little to add.

Responses to the general issues raised by you are attached. If you have further questions, please contact Capt. James C. Waugh, Senior Vice President-Operations, at 212-632-5683.

Thank you for the opportunity of responding to this important question.

Very truly yours,

Attachment

Response to General Issues

1. Historical perspective

   This is best covered in the report of the Aeronautics and Space Engineering Board's Woods Hole Workshop.

2. Current benefits of a strong aeronautical industry.

   .1 Strong national and international transportation system. Better internal and external communications.
   .2 Employment in manufacturing, airline and supporting industries.
   .3 Favorable effect on international trade balances.
   .4 Potential reserve for military transportation.

   Relationship of NASA sponsored aeronautical research and technology. See transmittal letter and ASEB Woods Hole Workshop report.

3. Foreign technological efforts

   See transmittal letter.

4. Industry needs

   Much R&T can be and is accomplished by industry, but the contribution of NASA is needed to maintain U. S. leadership. Some of the investments required (for example: large advanced wind tunnels) are too expensive for individual companies to sponsor. It is very doubtful that the U. S. could compete successfully with foreign aircraft or transport systems if Federally sponsored R&T were seriously curtailed. Foreign governments are following an opposite policy: more government support of R&T.

5. Is an independent NASA important to the military?

   We believe it is. A possible analogy is the comparison of Army tank programs with Air Force and Navy aircraft programs. A recent authoritative British publication rated the latest U. S. Army tanks as inferior to current production Russian tanks. Current F-14, -15, -16 and -18 fighter aircraft appear superior to any others. The Army does not have available an equivalent to NASA.

6. Should NASA continue in both research and technology developments?

   Yes. Technology transfer to useful products should depend little on governmental involvement. If the results of NASA R&T are promptly made available to the manufacturing and operating industry, transfer will automatically be prompt and efficient.

7. Should NASA continue in all of the primary research areas in which it is presently engaged?

   We suggest that this be reviewed again by a competent and representative group of interested technical people, in light of current and projected future circumstances. There may be items which could be deleted without detrimental effect on the overall picture. But we do not believe this includes propulsion research. Withdrawal from propulsion research would probably result in gradual but none-the-less certain deterioration of the American transport and military aircraft engines.

Dr. Michael I. Yarymovych
Vice President
Engineering

North American
Aerospace Operations
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Rockwell
International

December 18, 1981

The Honorable Dan Glickman
Chairman
Subcommittee on Transportation,
Aviation, and Materials
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

I appreciate the opportunity to respond to the request for our views on the continuing participation of NASA in aeronautical research and technology. We, at Rockwell, feel very strongly that NASA continue to support this effort and we know, from direct participation on the NASA work to date, that the product is invaluable.

Furthermore, because many of the new initiatives in our nation's strategic revitalization program are aeronautics oriented, it is essential for our defense posture that a healthy aeronautical R&T program be continued.

We have commented specifically on the seven issues defined in your request and they are attached to this letter.

Sincerely,

M. I. Yarymovych

M. I. Yarymovych

Enclosure

THE FIRST "A" IN NASA

Issue 1. Historically, NASA and its predecessor NACA have been the vanguard for aeronautical research in all facets of aircraft. Without this research, the United States could not have achieved and maintained its world-acknowledged pre-eminent position in aeronautics and astronautics. This pre-eminence made possible aircraft which are performance leaders of their time.

Examples of NACA/NASA Contributions to NAA/Rockwell Aircraft Designs

B-70 Compression Lift Principle - Directly based on NACA research in 1950's.

B-1 Variable Sweep - Directly influenced by NACA/NASA research on use of variable sweep in 1950's and 1960's.

Area Rule Approach for Transonic/Supersonic Drag Reduction - Early NACA semi-empirical approach led directly to theoretical analysis and resultant wave drag math models.

Supercritical Wing Section Approach for Delay of Transonic Drag Rise -
Early NASA semi-empirical approach led directly to theoretical analysis techniques for wing section design.

Classical examples of NASA-industry cooperation are the X-15 and HiMAT programs. In these instances the resources of NASA were utilized to vary parametrically the important aerodynamic geometric features. This systematic development allowed the industry contractors to more directly address baseline concepts which were evaluated for merit. In the case of the X-15, extensive research was required to open the flight boundaries. In the HiMAT development, closely coupled canard arrangements were investigated leading to a transonic design objective which surpassed all previous endeavors. In both instances, the aeronautical sciences were advanced by the NASA and developed into flying systems by the contractor.

A more recent example, and larger scale, is the aerodynamic shape of the space shuttle orbiter vehicle. Development of the atmospheric configuration of elements extensively utilized the facilities of NASA. While the orbiting aspect of the shuttle were important, all the configuration design elements were associated with atmospheric flight including heating, stability and control, and landing characteristics. Extensive use of NASA test resources to define vehicle performance were mandated.

Stall-Spin determination is another area where the NASA, with its specialized facilities, functions as an advisor and evaluator. Because of the complex nature of this technical area research and development has lagged airplane designs until recently when effort has been expended to design for spin resistance.

Through the advanced research of NACA/NASA transonic and supersonic flight was made a reality. They developed the first reliable means of testing in wind tunnels at transonic speeds and developed the X-1, the first manned vehicle to achieve Mach 1 and the X-15, first manned vehicle capable of high supersonic and hypersonic speeds. This research work provided the technical understanding and "real world" confirmation that made possible the B-70 and SR-71 Mach 3 aircraft as well as virtually every one of the military aircraft produced by this country. NACA's comprehensive test and analysis program for supersonic inlets in the early to mid-50's provided the base for many of the supersonic aircraft inlet designs which followed, and it still provides an excellent base of knowledge for future designs.

Examples of NACA/NASA Contributions to Industry Other than Rockwell

Variable-Sweep (F-111, F-14)

Solution in cooperation with military and industry of inlet/engine/airframe compatibility problems of F-111.

Solution in cooperation with military and industry of base drag problem of F-14.

Issue 2. Current Benefits of a Strong Aeronautical Industry

Since the aeronautical industry is strongly associated with and is a major contributor to national defense, the aeronautical industry must lead the world.

This lead in military technology has directly resulted in a U.S. lead with commercial aeronautical industry through the transfer directly of the technology base to commercial applications.

A strong leadership in commercial aviation provides the basis for a large industry that contributes significantly to the overall well being of the total economy.

Issue 3. Foreign Technological Efforts Devoted to Overtake the U.S. Lead

Our foreign competition is devoting greatly increased resources in overcoming the U.S. lead. In the UK, Germany and France, significant government investments are being made in aeronautical R&T. This is evidenced by the efforts currently being expended in the areas of energy-efficient transports, general aviation, and specialized aircraft as well as various military tactical aircraft.

Issue 4. Does Industry Need the Contribution or Could Industry do its Own R&T?

Although industry definitely has the technical capability to do its own R&T, it probably would not do an adequate job because of economic constraints on individual companies. With the loss of NASA support, the economics would lead to a deterioration of the resources dedicated to the longer range and high-risk items.

Even if individual companies had the necessary economic resources, they would act to protect their own proprietary developments. The result would be uncoordinated and unresponsive R&T developments that could erode U.S. leadership in the aeronautical industry.

Conversely, NASA in conjunction with the established industry committees can direct R&T in the direction for best overall effect. Each industry member then is free to develop their own proprietary R&T to supplement the national program.

Issue 5. Is an Independent NASA Important to the Military?

NASA provides the independent or third party capability to evaluate competing designs for the military. This has historically been a significant advantage to the military, in that they can call on the NASA expertise as required.

In addition to the evaluator potential of the NASA, the military has repeatedly invoked NASA help as the expert consultant to solve problems encountered during on-going programs. This expertise, along with NASA's considerable laboratory facilities has been and will be an invaluable tool for the military. In this consulting role, NASA provides the assurance to the military that state-of-the art technical methods are being utilized by industry.

Issue 6. Should NASA Continue in Both Research and Technology Development?

NASA can and does contribute to both research and technology transfer. This transfer can only be useful however if NASA, together with the military, properly coordinates technology development in the "proper" direction. "Proper" in this sense means that the development directly aids an ongoing industry program. This direct aid can only result if NASA solicits and accepts industry suggestions. Recent past history shows that this mutual interchange between NASA and industry has during some years been only marginally fulfilled. Future use of NASA in both research and technology development must be contingent on closer cooperation with industry.

The foregoing indicates NASA can and should continue in R&T. Referring specifically to research only, NASA still needs a relatively free hand in its research programs in order to achieve true research benefits. Once this research advances a particular portion of the aeronautical science beyond state-of-the-art, the resultant technology transfer must be assured.

Industry can and should participate with NASA in both R&T on a subcontract basis. In other words, NASA should set aside a significant percentage of its total program to be performed by appropriate industry participants.

Issue 7. Should NASA Continue in All of the Primary Research Areas it is Presently Engaged In?

NASA should definitely continue in these primary research areas in which it has been historically engaged, i.e., aerodynamics, materials and structures, and propulsion.

In regard to NASA's withdrawal from propulsion research, this would tend to reduce the future benefit of such R and T efforts, as variable cycle engines for mixed supersonic mission applications (civil and military), clean burning combusters for environmental benefits, higher risk developments such as the high speed propellar for which a need is perceived for fuel economy but no current aircraft is identified, and ceramic engine components. Developments by the engine manufacturer tend to be much nearer term in terms of payoff and competitive advantage.

UNIVERSITY OF COLORADO
College of Engineering
and Applied Science
Office of the Dean

December 15, 1981

The Honorable Dan Glickman
Chairman, Subcommittee on Transporation,
Aviation and Materials
Suite 2321 Rayburn Office Building
Washington, D.C. 20515

Dear Congressman Glickman:

I appreciate this opportunity to provide you with written testimony on the first "A" in NASA. I have been a professor of aerospace engineering for twenty years and I currently chair the National Research Council's Aeronautics and Space Engineering Board (ASEB).

You are no doubt aware of the ASEB's views regarding the role we feel NASA must fulfill in aeronautics for the coming two decades. Other members of your subcommittee might wish to refer to the summary document from the week-long workshop the ASEB held in July, 1979.[1] This document addresses most of the questions raised in your enclosure. Your subcommittee has already heard articulate oral testimony on the issues you have raised. Four of your witnesses are current or former members of the ASEB. Consequently, I will make my remarks brief and provide you with my personal perceptions of the major issues you wish addressed.

We all regularly use and enjoy the efficient and effective air transportation available to us from the private sector; we reap the rewards of more than a ten billion dollar foreign trade surplus from the aeronautics industry; and we also are well protected by the aeronautical capabilities of our national defense. These benefits derive from the small (now about $300M) but continuous investment in aeronautics research and development carried out by the NACA/NASA over nearly three quarters of a century. The relationship between the NASA and the aeronautics industry is unique and without parallel in this country. Our investment in the promotion of this relationship has brought us substantial rewards. The forces that drive our industrial system do not encourage this continuous investment in research and advanced technology. Witness the railroads, the steel industry, and the automotive industry. Indeed, witness the aeronautics industry: in the early 1970's Boeing closed the Boeing Scientific Research Laboratories which, at that time, had the best collection of young aeronautical talent in the world. That talent is now widely dispersed but individually famous.

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1. NASA's Role in Aeronautics: A Workshop, Volume I Summary, National Academy Press, Washington, D.C., 1981

AD 1-1 Engineering Center • Campus Box 422 • Boulder, Colorado 80309 • (303) 492-5071

The evidence is manifold that we cannot rely on industry to provide the long term investment in research and advanced technology for them to remain competitive indefinitely. Our aeronautics leadership, which spans more than three quarters of a century, has been maintained, in part, by our investment in this leadership through the NACA/NASA for most of this period. If we are to maintain this leadership, we must not only maintain NASA's aeronautical programs, but strengthen them.

Let me turn now to your list of General Issues and address them in the order they were raised.

1. From the historical perspective, how has NACA/NASA contributed to our national security and economic well being?

In my field of aerodynamics alone, the NACA/NASA has contributed to hundreds of fundamental advances. Let me just site a few familiar ones: The area rule for reducing wave drag at supersonic speeds; supercritical aerodynamics to reduce drag in near sonic flight; computational aerodynamics with its coming great impact on aircraft design; and inlet duct acoustics that helped reduce the noise of our jet transports.

2. Current benefits of a strong aeronautical industry. Relationship of NASA-sponsored aeronautical research and technology development to those benefits.

The benefits are efficient transportation, a strong defense, and a favorable trade balance. The whole spectrum of NASA aeronautical programs is responsible for these benefits, but NASA's efforts in research and advanced technology have provided the greatest return on our investment.

3. Foreign technological efforts (programs/resources/facilities) devoted to overtake the U. S. lead.

There are concerted efforts in Europe and in Japan to challenge our leadership in commercial aeronautics. The Soviet Union continues to invest substantially in aeronautical developments. European inroads into our commercial markets are now evident. Various mechanisms to subsidize these efforts are in place in both Europe and Japan. Our response should be to enhance NASA's aeronautical capabilities.

4. Does industry need the contribution of NASA or could industry do its own R&T? Are the economic incentives great enough to induce industry to make the necessary investments? Could the U. S. compete successfully if Federally sponsored R&T were curtailed?

Again, let me remind you there is much evidence that the economic incentives for a continuing investment in research and advanced technology are not evident to industry. The railroads, the steel industry, and the automotive industry all thought they had more important investments to make than in continuing the research that originally established their industrial base.

5. Is an independent NASA important to the military? What role does NASA play in the development of military aircraft?

Most of the fundamental advances that have provided our aeronautical superiority have come from the NASA or from the universities under both NASA and DOD sponsorship. NASA has had and continues to play an important role in the development of military aircraft. A notable recent contribution is the rapid advance in the computation of aerodynamic flows pioneered by the NASA.

6. Should NASA continue in both research and technology development? To what extent does technology transfer, to useful products, depend on government involvement in both kinds of activity?

As I noted earlier, generally NASA's efforts in research and advanced technology have been the most cost effective. But there are high risk, high pay off technologies that must occasionally be demonstrated before they are carried over into commerical or military use. Currently, there are several such technologies that could all be demonstrated in a small aircraft for the commuter industry, viz., composite materials for primary structures; fly-by-wire, active controls; and, in a few years, advanced turbopropellers. Some demonstration of composite materials for primary structures is urgently needed.

7. Should NASA continue in all of the primary research areas in which it is presently engaged? What might be the consequences of a NASA withdrawal from propulsion?

NASA must continue to focus its efforts on materials and structures, aerodynamics and propulsion. We cannot withdraw from propulsion research without dire consequences to the aeronautics industry, any more than we could withdraw from aerodynamics or materials and structures research.

In closing, let me reiterate again my main point. Our aeronautics industry remains at the forefront because of our small but continuous investment in the NASA aeronautics program. To believe that industry will do this as well as NASA, with proper incentives, seems to ignore the past history of most other industries. Within the context of our strong belief in competition, the unique partnership between the aeronautics industry and NASA should serve as a model for government investment in other sectors, not the converse.

Sincerely yours,

A. Richard Seebass

A. Richard Seebass
Dean
Chairman, Aeronautics and
Space Engineering Board

xc: ASEB Members

P.S. I have avoided addressing the serious consequences this country faces if it continues its unwillingness to invest in graduate engineering education, as this issue is only tangential to those you raised. But the NASA must participate fully in any programs that are developed to address this issue.

TELEDYNE CAE
Turbine Engines
1330 LASKEY ROAD
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ROBERT P. SCHILLER
Vice President, Strategic Planning
and Assistant to the President

21 December 1981

The Honorable Dan Glickman, Chairman
Subcommittee on Transportation, Aviation and Materials
Committee on Science and Technology
U.S. House of Representatives
Suite 2231 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Glickman:

We appreciate your invitation to respond with written testimony for the hearing on the first "A" in NASA.

Teledyne CAE is a relatively small company, dedicated solely to research, development and production in the field of small aeronautical gas turbine engines. As such, we are in a position to offer a direct and knowledgable appraisal of NASA's role in, and benefit to, Aeronautics research particularily in support of the U.S. military. We, therefore, are directly responding to your questions regarding propulsion. More specifically, we will address small to medium-sized turbofans, turbojets and shaft machines. Teledyne CAE engines currently power military trainers, strategic cruise missiles, tactical missiles and remotely piloted vehicles. This technology may also have future application to commercial commuter transport and business jets and other General Aviation aircraft, as well as to military and commercial helicopters.

In our opinion, United States military and commercial competitive capabilities are now being eroded by the inadequacies of R&T investment to maintain technology and productivity supremacy. Foreign consortia of governments supporting their domestic industry, especially in France, Great Britain and Japan, are developing new, more affordable products and are successfully invading U.S. markets - both domestic and abroad. The only possible response to this challenge is to make available to United States industry the fruits of high benefit-to-cost research. This is what the first "A" has done, and what had been programmed by NASA prior to recent budget cut announcements.

Specific Teledyne CAE comments to the general issues of your letter are attached but I would like to highlight the impact on our defense posture of the proposed NASA budget cuts.

The present NASA emphasis on generic technology development makes it possible for the United States Defense Industry, and, unfortunately, any foreign country, to maintain awareness of the state-of-the-art in technologies not being used in their current products. Generic technology developed under

NASA guidance is generally shared. Technology developed using internal funding is held as proprietary to bolster the company's competitive position. To develop a small gas turbine engine costs $80M to $150M, and takes many years, even when the underlying technology is available, as it is now under current NASA guidance. If the basic technology were not generally available, engine development would require still more money and time. The funding requirements would essentially eliminate competition as the losers in near-term engine competitions would quickly bankrupt themselves, each attempting to separately develop the proprietary technologies required to be technically competitive.

Department of Defense programs, being constrained by the pressures of time and available program funding, are forced to minimize risk through use of essentially proven technology. Continuing development of this technology is specifically where an independent NASA has enabled the United States to maintain technical leadership in the world. Dismantling of NASA expertise and facilities would seriously compromise the ability of the United States to remain the leader in the defense of the Free World.

Sincerely,

Robert P. Schiller

RPS/yw

Attachment

The First "A" in NASA

General Issues

The Committee on Science and Technology has received inputs from the large aircraft and engine manufacturers, describing the multi-billion dollar payoffs of NASA research in Energy Efficient Engines, aircraft structures, and controls. This payoff includes the technology transfer to, and cooperative programs with, military air vehicles. Teledyne CAE supports those arguments and echoes the sentiment that, for example, closing the Lewis Laboratory would send a shock wave through the propulsion community, depriving the propulsion community of precious and unique facilities and brain-power expertise which most probably cannot be duplicated (in truth reinvented) by private industry or by the Department of Defense. Members of our staff visit Lewis Laboratory regularly, exchanging program information and seeking advice. The NASA Lewis staff is exceedingly generous in opening to us their Government-funded expertise.

We heartily endorse the Administration's fiscal policies, where those policies reject a philosophy of "Let's throw a lot of money at the problem and see if it solves something". This is not the case of the NASA Aeronautics budget for Research and Technology.

NASA has operated within policies of generic, minimum product-oriented and maximum long-term payoff research, using in-house development, contracted efforts and cooperative programs with industry and DOD. These policies have provided a wellspring of technology which has benefited U.S. defense capability, contributed heavily to improving our balance of payments, and maintained an expanded base for potential future military needs on a wartime surge basis.

The balance of payments, employment and energy usage reduction issues extend beyond the obvious and well-known large commercial aircraft and engine sales to the more numerous (but lower dollar value) smaller General Aviation and helicopter products. Universal publication and direct communication of NASA research results to U.S. companies makes these advances available to any of us who wish to use them.

With these remarks as an introductory indicator of our extremely strong sentiments against the gross reductions proposed for the Aeronautics budget, we would now like to address the general issues you raised in your letter.

1. In our industry, direct payoffs have come from fundamental NASA research between 1945 and 1980 on the transonic axial compressor, which made United States power plants preeminent in compactness, weight, cost and performance. More recently, technology has been transferred from new wing shapes to even more advanced compressor airfoil shapes providing additional strides in fuel efficiency. Many modern computer design codes for propulsion systems were developed by NASA and are in widespread use. These innovations and the broad generic base of the NASA information have been applied to both commercial and military power plants.

2. The past has thus shown major national benefits of NASA leadership to the aeronautical industry. Current and future NASA programs in Teledyne CAE's areas of interest focus on: small engine component research; new quiet, more efficient propellers for General Aviation; advanced turboprops; engine control theory; alternate fuels research; high (cooled) turbine inlet temperature research, and Computational Fluid Mechanics.

NASA has recently reevaluated its role in Aeronautics research at its Woods Hole Symposium. NASA concluded that its out-year planning should be tilted more towards generic technology development and away from the larger, more expensive system demonstrator efforts. The latter programs have produced the Energy Efficient Engine results (your Committee has been well informed as to the large E^3 payoff in commercial aircraft fuel conservation, pollution and noise reduction). Pollution and noise reduction have also been fundamental objectives within the NASA R&T base for the last several years, with payoffs currently showing up in a broad band of aeronautical products. This large systems demonstrator type of effort can probably be continued by large engine companies on internal funding, using current and future fundamental technology gains fostered by NASA's sponsorship.

As funding is becoming more limited, NASA is moving toward less contracted effort and more cooperative programs with industry. This will maintain NASA internal expertise and make the special facilities, especially at the Lewis Laboratory, available to Industry.

The impact of the planned emphasis on generic research will be felt most strongly in the small engine industry. Each of the research programs offers outputs not available within the limited assets of General Aviation or small engine contractors. Domestic and foreign sales of U.S. built 10-50 passenger commuter, transport and General Aviation aircraft and helicopters will be deteriorated if these research programs are cut. Foreign limitations on noise of propeller-driven aircraft demand improvement of U.S. built smaller aircraft and are now limiting sales.

Other technology line items of this projected Research and Technology budget address our ability to design with greater accuracy and predictability, thereby increasing productivity. This will reduce the costs and risks of new engine development by reducing the front end investment required for complex new products.

3. British, French, Canadian and Japanese propulsion companies work hand in hand with their government agencies, or are government-owned and/or subsidized. Engines are developed under government contract for military and civilian use in a far more harmonious and supportive atmosphere than the approach used in the United States. Rolls Royce (UK), Microturbo (France), SNECMA (France) and Pratt & Whitney (Canada) are prime examples of companies whose propulsion products are technically attractive and highly cost competitive with ours, primarily because of their propitious government/industry relation.

4. Large United States propulsion companies, even with their heavy current R&T investments, cannot individually counter these influences. Smaller companies, such as Teledyne CAE, do not have the capital assets to compete alone on all fronts. This is especially true in generic areas of advanced technology where, while payoffs are high, risks are correspondingly so. Future products are directly tied to the research being accomplished today. A company's operational cost effectiveness, performance and affordability, and the ability to compete in either the military or the commercial marketplace, are a direct output of that research. Costs of this research have increased more than normal inflation as the technology base has been extended to more sophisticated products. In the propulsion field it often takes up to twelve years from the time a new, more sophisticated high-technology product is conceived, until it is in production and earning a profit. Development of a medium sized engine to production initiation can take $80-$150M; this is the equivalent of one to two years gross sales for a company our size.

Therefore, with the high cost of research, extraordinarily long lead time to product maturity, and uncertainty of the ultimate market, U.S. industry is not in a position to make all of the necessary investments in a timely fashion. Due to asset limitations and the high, long-term investment risk, output will either be absent or too late in arrival to be effective in the competitive environment. This general statement is especially critical in the smaller companies' business environment.

These investment factors are almost unique to aeronautical propulsion due to the product lead times and the high technology involved.

NASA leadership in the areas of generic research outlined above is necessary to complement the already heavy company funding and limited Department of Defense research investments in long-range efforts. Without the extended research assets provided by NASA, we can foresee the possibility of the smaller United States engine companies being bought up or forced out of business by the larger U.S. or foreign competitors.

5. There is considerable spin-off from NASA programs to the military. The most obvious and direct current role is in the area of rotorcraft, where the U.S. Army has co-located personnel and laboratories within NASA facilities. Other areas involve technology feedback from NASA's "cutting edge" or "frontier" research and availability of NASA expertise to military programs. While the military are heavily involved by necessity in nearer term weapon systems of more assured technology, NASA is addressing the broader spectra of non-product oriented aeronautics in both engine and aircraft technologies which affect Air Force and Navy advancements. To be effective in these areas, NASA must be independent, addressing technologies rather than programs. Basic technology is most effectively developed apart from the parochial pressures of specific military programs.

6. We believe NASA should follow the new policy guidelines developed at the Woods Hole Symposium referred to above. This leads to more funding emphasis on generic technology advancement and less on systems demonstrators. The

output is therefore both research and technology development, but does not necessarily involve product-oriented, full-scale demonstrators. Planned programs on cooled turbine heat transfer, alternate fuel usage, propeller noise and efficiency, small engine components, and advanced turboprops are examples of how government involvement will promote technology transfer and improve U.S. products. These programs will be partly run in-house at NASA and partly contracted to industry. This combination insures maximum availability of the basic research and technology validation information, and also active participation by industry in the very long lead time of new product concepts. Without the cooperation and leadership of such NASA programs, technology transfer would be minimized by proprietary interests. Any company which undertakes a long term, high risk, very expensive technology development program would consider the results to be proprietary.

7. It is difficult to comment on all of the primary research programs in which NASA is now engaged. Certainly in the propulsion area, we believe that almost all of the areas now being worked on should be continued. It is only recently that small propulsion engine research has received much attention, hence a withdrawal of NASA from propulsion would seriously hurt the small propulsion companies such as Teledyne CAE (i.e. those companies with the least resources to carry on independently). The cost of research does not scale down with the size of the engine. Therefore, elimination of anticipated NASA advances in Computational Fluid Mechanics and sponsorship of research for more fuel-efficient, compact and mission-effective engine component technologies will only increase the cost and risk of engine development; it will also reduce the ability of this Industry to provide better engines for the Department of Defense and commercial usage.

We, therefore, firmly agree with the large number of our colleagues who have provided definitive testimony to your Committee on the tangible and intangible benefits of NASA as a precious national asset in Aeronautics.

The question is not whether NASA should be allowed to continue to support aeronautical R&T. Rather, it is whether the current and planned limited budgets are adequate to maintain a U.S. lead in these areas. The demonstrated payoffs have been an increased national security, fuel and environmental conservation, billions of dollars in balance of trade benefits and meaningful employment of thousands of professional and labor workers. Curtailment of NASA support in Aeronautics will assuredly minimize the chances of continuing these significant benefits to the U.S. economy.

UNITED AIRLINES

Office of the Chairman

December 17, 1981

Mr. Dan Glickman, Chairman
Subcommittee on Transportation,
Aviation, and Materials
Committee on Science and Technology
U.S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mr. Glickman:

Thank you for the opportunity to comment on NASA's partnership with the aviation industry. We are pleased to submit our views for inclusion in the record of the hearing on The First "A" in NASA.

We feel very strongly that a meaningful program of federally-sponsored research and technology development serves the national interest. We disagree with those that suggest that the NASA Aeronautics program should be curtailed.

The commercial aviation industry, NASA, and Department of Defense are joint parties in the development of aviation technology. There is a great interdependence; and if any part is weakened, the entire structure is endangered.

It is ironic that some quarters are proposing to reduce further the NASA Aeronautics program which, over the last decade, consistently has been only 5% to 6% of NASA's total annual budget. The remainder of the budget has been directed to expensive programs in space science, satellite tracking, exobionics, planetary exploration, and the like. The justifications for these programs, as beneficial as they are to the national prestige, security, and economic well-being, are equally applicable to an even more aggressive aeronautics program with more immediate, tangible and predictable real benefits. Rectifying the short-fall in aeronautics R&D would make a cost effective contribution to the national well-being, and it is necessary if this nation is to remain the leader in civil and military aviation.

P.O. Box 66100, Chicago, Illinois 60666 - Location: Elk Grove Township, Illinois, on Route 62, one-half mile west of Route 83

Below is our response to the "general issues":

1) From the historical perspective, how has NACA/NASA contributed to our national security and economic well-being? (examples of NACA/NASA contributions to progress in both civil and military aircraft would be useful)

   NACA/NASA has enhanced safety and efficiency for the traveling public and shippers throughout the world. Some examples of areas where NACA/NASA have made significant contributions: defining gust load requirements; airframe, propeller and powerplant icing data; aerodynamic data which improves operating efficiency, reliability and eliminates the need to stretch runways everytime a new large aircraft is introduced; validation data justifying elimination of having to train in aircraft and the ability to assure required proficiency through use of simulators only; controlling aircraft during deceleration on wet runways; propulsion advances i.e. improved materials, noise reduction, fire suppression, composite materials; improved flight control systems (hydraulic-electric); crashworthiness; and Human Factors related to people/machine interrelationships. Such findings, which are not all inclusive become available to the entire aviation community.

2) Current benefits of a strong aeronautical industry. Relationship of NASA-sponsored aeronautical research and technology development to those benefits.

   The national defense/national security benefits of a strong aeronautical industry are obvious. The domestic benefits of a strong aeronautical industry include employment, retention of manufacturing infrastructure, favorable balance of trade, international trade preeminence, and an internally self-sufficient domestic transportation system. NASA sponsored aeronautical research is going to be absolutely vital in the '80s. We, and other airlines, are trying to encourage development of a new generation of aircraft. Our performance standards, to assure economic viability, will require quantum improvements in airplane/engine performance. This will require years of extraordinary research and development. The commercial sector is heavily dependent on NASA to provide this effort.

3) Foreign technological efforts (programs/resources/facilities) devoted to overtake the U.S. lead.

The success of aircraft like the A-300 Airbus in world and domestic markets is a direct outgrowth of multi-national cooperation in financing, production, design, and research. Joint ventures in construction and operation of scientific research facilities in Europe is now a way of life. United States leadership in research is being seriously challenged in this area.

4) Does industry need the contribution of NASA or could industry do its own R&T? Are the economic incentives great enough to induce industry to make the necessary investments? Could the U.S. compete successfully if Federally sponsored R&T were curtailed?

Industry has neither the finances nor facilities to replace the NASA Aeronautics effort. We must bear in mind that the bulk of NASA Aeronautic activities are high risk ventures. Individual manufacturers would have considerable difficulty gaining approval for allocation of major investments in such efforts. Even if they did on some occasions, the findings would be proprietary and not generate the widespread benefits emerging from NASA data.

We would expect that curtailment of NASA research levels would a) seriously curtail aircraft development work in this country, b) drive domestic research into foreign facilities, c) cost the U.S. loss of technological pre-eminence, and d) result in loss of aircraft sales to foreign competitors.

5) Is an independent NASA important to the military? What role does NASA play in the development of military aircraft?

Yes. Comments on NASA's contribution in Item #1 is also applicable here. A very simple example is the development of the C-5 and 747 aircraft. The level of technology required of both the airplane and engine had to be demonstrated before Air Force or commercial procurement programs could commence. This was done over a period of years in DOD, NASA, University, and Commercial research facilities. In some cases, these were joint NASA/University, NASA, or NASA/Commercial research efforts. Engine, wind tunnel, and structural development work pioneered by NASA provided the building blocks needed.

6) Should NASA continue in both research and technology development? To what extent does technology transfer, to useful products, depend on government involvement in both kinds of activity?

Absolutely. Research by itself is useless unless some validation is accomplished. There is an impression that NASA develops a finished product which is taken over by a manufacturer to realize profit. Nothing could be further from the truth. At best, technology development or validation involves a bread-board type unit, which is really an extension of research, and used for the purpose of determining whether findings do or do not have merit. It frequently is just as important to learn what will not work as that which will. Subsequent to validation, the manufacturer then takes over and underwrites product development. We believe NASA validation data plays an important part in the FAA certification data.

7) Should NASA continue in all of the primary research areas in which it is presently engaged? What might be the consequences of a NASA withdrawal from propulsion?

Yes. Withdrawal from propulsion development would be devastating. Development of a new generation of aircraft is going to require improvements in engine fuel consumption efficiencies in the order of 25% - 40% above current widebody engines. This will require a research and development program at even higher levels than now being funded. We are already seeing the benefits of the energy efficient engine program and we have high hopes for the advanced turbo prop project.

Sincerely,

Richard Ferris

Richard J. Ferris
Chairman

RJF/jj